PESTICIDES ENGINEERING CONTROL TECHNOLOGY

ASSESSMENT SURVEY

129-19a

PLANT M-5 SURVEY December 1979
REPORT February 1980

Stauffer Chemical (?)

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(NIOSH Contract 210-77-0093)

This report is intended to describe effective applications of control technology which may be of general use to the pesticide manufacturing and formulating industry; it is not intended to describe all aspects of control programs in this plant.

INTRODUCTION

Plant M-5 formulates several pesticides, both as liquids and granular solids. Most liquid products are packaged in five gallon steel cans, and the granular product in 5, 10, 25 and 50 pound bags. While most of the products are of relatively low toxicity (LD_{50} greater than 1000 mg/kg), one product is extremely toxic (LD_{50} from 10-20 mg/kg). Low toxicity technical pesticides are shipped to the plant in 20,000 gallon railroad tank cars and are unloaded from the top. These compounds have low vapor pressure and do not present a severe evaporation problem.

The plant employs between 50 and 60 people and operates two shifts per day, five days per week. Maintenance is performed by the company's employees. The plant has an excellent safety record with over 2800 days without lost time injury. This record is a result of the effort made by the company to provide a safe workplace and to enforce good, safe work practices.

Certain general process engineering measures were noted as contributing to this record as well. First, simplicity in handling and equipment is sought. As an example, the use of mechanical tank level sensors is preferred over electrical devices because of the relative ease of adjustment and the thereby lessened exposure risk during maintenance. Second, quality control sampling is held to the minimum necessary for regulatory purposes and documentation by exercising strict control over batch quantities. (Quality control sampling is often a source of exposure.) Third, the quantity of material stored at any one location is limited, this reduces the risk of a fire or explosion which could produce a massive emission of combustion products.

MEDICAL, INDUSTRIAL HYGIENE AND SAFETY PROGRAMS

Medical Programs

Emergency medical services are provided by the emergency room of a nearby hospital. The hospital is briefed on the products handled in the plant and has the proper antidotes on hand. The company retains a physician who supervises the medical program under direction of the corporate medical director. Blood samples are drawn periodically and analyzed at an independent clinical lab. Annual physical exams are given to all plant employees.

Both red blood cell (RBC) and plasma cholinesterase are determined monthly for all personnel with significant process contact. If RBC cholinesterase is lower than 80% of baseline (20% depression) then another sample is taken immediately. Upon confirmation of the 20% depression, the affected worker will be removed from process contact until he returns to normal. His work practices and the environmental conditions at his work station will be examined.

Safety

The plant management is extremely safety conscious and is proud of a record of 2800+ days without a lost time injury or illness. Safety meetings are held three times per month.

In general, the plant has appropriate, up to date safety equipment and practices. Potential hazards are appropriately identified and instruction for protective gear is provided. Products are segregated according to their form and toxic hazard, and buildings and areas are well posted with warning signs. The corporate hygienic guidelines, describing the essential elements of the plant programs, are given in Appendix A.

Industrial Hygiene

The plant industrial hygiene program, although directed from corporate headquarters, is carried out on-site by plant personnel. The plant environmental chemist is responsible (through the plant manager) for air sampling and analysis. A modest but adequate stock of sampling and evaluation devices is kept on hand, including:

1 - Alnor Velometer®
1 - General Radio 1565B sound level meter
4 - DuPont low flow sampling pumps
2 - Bendix BDX-44 pumps
2 - Bendix C-115 pumps
Smoke tubes
Draeger colorimetric indicating tubes and pump

The pumps are calibrated according to accepted standards before and after each use. Sampling and analytical methods are not generally available for many of the compounds handled in this plant and substantial effort has been made to develop adequate methods. In general, sampling for any of the pesticidal compounds is performed with a two-stage collector

- o 37 mm mixed cellulose ester filter (0.8 mm mean pore size, Millipore Aerosol Monitor®), followed by
- o Solid sorbent sampling tube for vapor collection.

The corporate and plant industrial hygiene staff have found substantial losses of active ingredient may occur when a filter alone is used, even for compounds of relatively low volatility. The sorbent material of greatest general utility is Porapak®, although Chromosorb® 102 or 104) and Tenax® are more suitable for some compounds.

Sampling is carried out in designated areas on an ad hoc basis, but generally samples are taken in the most potentially hazardous areas before and after any process changes and routinely once every 2-3 months. This sampling effort has been carried out for approximately 4 years. Analysis is carried out in the corporate AIHA-certified IH laboratory.

Initially, it was hoped that simple total dust measurements, with gravimetric analysis performed at the plant, would permit adequate monitoring of contamination, without continuing resort to the relatively elaborate analytical methods needed for determination of the active ingredient. Evaluation of results, however, convinced the industrial hygiene staff that the correlation between total dust and active ingredient concentration was insufficient, and that the more complex procedures were necessary.

As noted in Appendix A, wipe sampling is carried out monthly in several plant areas. This wipe sampling is intended to detect significant contamination of "clean" areas so that the sources may be sought and corrected. Mere trace contamination is a concern, as it indicates non-compliance with established work practices.

Corporate air concentration limits are set by a company industrial hygiene guide committee, composed of medical, industrial hygiene and toxicology personnel. The company has a staff of over 90 professional toxicologists to draw upon in this effort.

A new change house is currently being installed at a cost of $900,000. This unit has separate men's and women's sides; each of these has a "clean" (street) side, and a "dirty" (plant) side.

Personal protective equipment currently issued routinely to all production personnel is

Socks
Underclothing
Cotton coveralls
Hard hat
Safety glasses
Rubber boots
Where needed, respirators (NIOSH-certified for pesticide use) and gloves (Ansell Canner's and Processors #1212) are issued as well.

The guidelines for use of this equipment are given in Appendix A to this report.

AIR POLLUTION CONTROL

A continuing program of air pollution control is operating at this plant. Many of the compounds formulated here are phosphorous compounds with malodorous trace contaminants detectable by smell at concentrations of 0.1 ppm. Significant efforts have gone into control of the odor problem, with substantial reduction of other chemical emissions as a by-product of this effort.

Although details of the air pollution control systems were not generally made available for this survey, one effective system is described in detail later in this report. Certain general precautions were evident:

- The warehouse was vented through carbon beds for vapor (odor) removal
- Dust collectors were often connected in series with the primary dust collector used to collect dust for recycling.

One general problem was discussed. The company has found that vapor emissions from baghouses may be substantial, even where particulate material is collected efficiently and the vaporized chemical is of relatively low vapor pressure. Desorption of adsorbed chemical from the surface of particulate substrate appears to be responsible, perhaps due to locally increased air velocity over the surface of the particle.

PROCESS: Warehousing product

PROBLEM Stability of 5-gallon cans on pallets

SOLUTION: Stretch wrapping

5-gallon cans of product are palletized three high, and several layers of pallets are stacked for warehousing. To prevent the obvious problem of a can falling from a pallet in transit or during a ware housing mishap, the cans are stretch wrapped immediately after palletizing. Stretch wrapping is preferred to shrink wrapping by this company primarily because of its fire retardant qualities. The stretch wrap, polyvinylidene chloride has a higher melting point and is less flammable (due to the chlorine present in the molecule) than the shrink wrap (polyethylene).

PROCESS: Storage of bulk liquid pesticides

PROBLEM. Spills and leaks

SOLUTION: Containment dike around tank farm

Several large tanks are used to store technical pesticides. The tanks are enclosed in a concrete containment dike which holds 110% of the capacity of the largest tank (250,000 gallons). Any spills and all rainwater collected in the dike are drained to the waste water treatment ponds, treated and then sent to ultimate disposal.

PROCESS Vents to atmosphere

PROBLEM. Dust and odor control

SOLUTION· Baghouse filter with activated carbon precoat

In one operation, both small quantities of fine particles containing pesticides and some volatile, odorous compounds are vented. To collect the particles a baghouse was installed. Although the baghouse controlled the particulate emissions, the odor problem still persisted. One option was to install a carbon bed or scrubber down stream of the baghouse. This would have been a costly option, and alternatives were sought. Since the particulate loading in the bag house was low (it is only shaken once per week), it was decided to purposely add more particulates, this time activated carbon. The carbon coats the bags, but does not increase the pressure drop enough to cause operating problems. It acts as a precoat filter and is more efficient in trapping the smaller particles than are the bags themselves. The carbon also adsorbs the volatile odorous compounds. The system is the subject of U.S. Patent 3,798,877.

A more detailed analysis of the system is given in Appendix B.

PROCESS: Pesticide formulation

PROBLEM: Process waste water treatment

SOLUTION: Multi step treatment, release of treated effluent to city sanitary sewer

Plant M-5 has intermittent, modest quantities of waste water which may be contaminated with pesticides or other potentially hazardous chemicals. Treatment is accomplished in a batch treatment plant, with subsequent discharge to the municipal sewer system.

The system is based on the following sequence of steps:

1. Chemical flocculation and activated (powdered) charcoal injection
2. Filtration
3. Biological treatment
4. Treatment in activated charcoal beds (3 stage)
5. Analysis
6. Discharge

Although there is considerable settling of sludge due to flocculation, this is handled by washing out the first tanks with a water (hose) wash and rinsing the collected sediment into the filter. The activated charcoal tanks are cycled when breakthrough is detected in the effluent from the first bed. The second bed then is placed first; the third is placed second and the replenished bed is placed third. Ground water monitoring wells are placed at strategic locations on the plant property, and sampling is conducted intermittently. Figure 1 shows the system.

PROCESS. Unloading of technical pesticide

PROBLEM Contamination of product

SOLUTION. Filter and then store in a diked tank farm

Technical pesticides are received in 20,000 gallon railroad tank cars. These liquids may contain foreign substances which could cause equipment failures downstream and necessitate maintenance and worker exposures. To insure that no foreign matter is introduced into the downstream processing, the technical product is first filtered, and then stored in large, dedicated tanks in a diked tank farm. Dedicated leased tank cars are used to avoid clean out of cars between services.

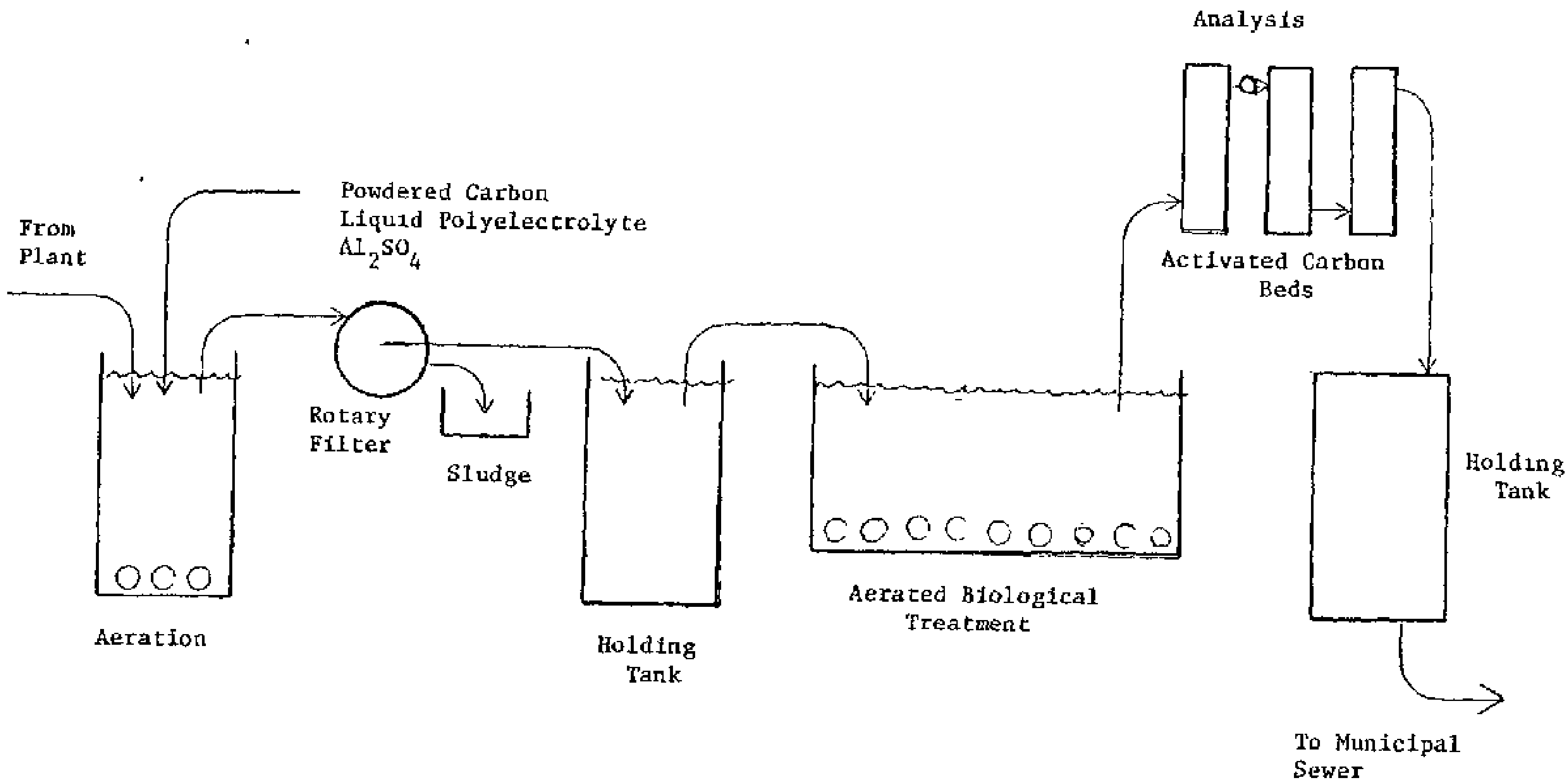

FIGURE 1 : Liquid Waste Treatment

APPENDIX A

Guidelines Hygiene Practices and Facilities

Pesticide Manufacturing and Formulating Plants

Agricultural Chemical Division (ACD)

These guidelines have been prepared to provide a consistent approach to general work practices and hygienic measures in our pesticide manufacturing and formulating plants. The objective is to eliminate or minimize potential exposures which may occur in processing agricultural chemical products. The purpose is to provide assurance that exposure to toxic chemicals by inhalation, ingestion, skin or eye absorption is minimized. We wish to protect not only our employees while on the job, but also their families and the community at large.

Our goal, therefore, is to adopt good work practices as described, or ones that are equally as good, to assure that potential exposures are minimized and confined to the controlled plant environment.

The Occupational Medicine Department recommends that each ACD plant carefully review the following guidelines and establish a written program to achieve the stated objective. Prior to implementation of that program, it should be submitted to the Occupational Medicine Department for review and approval.

A. Personal Protective Equipment and Clothing

Same as Section I.

B. Work Practices

All plants having areas with a potential for significant exposure to designated chemicals shall require that all exposed employees take supervised showers and change (from skin out) prior to lunch and at the end of the work day. No company supplied work clothing will be permitted to leave the plant for home laundering.

All other requirements indicated under Section I.

C. Sanitation

Same as Section I.

D. Contamination Control

Same as Section I.

I. <u>ALL PLANTS</u>

Definitions

a) "Impervious" means highly resistant to penetration by the material in question.

b) "Supervision" means periodic random checks made by supervisors. OSHA holds employers responsible for seeing that employees follow rules and regulations regarding safety and health.

A. Personal Protective Equipment and Clothing

1. Provide clean work clothing daily including, but not limited to, socks, underwear, coveralls, impervious boots, and gloves of an appropriate type, depending on the potential exposure. In the winter, it may be necessary to supply thermal underwear and outer clothing such as jackets. Outer clothing should be cleaned as needed or at least monthly.

2. Provide personal protective equipment daily including, but not limited to, hard hat and chemical safety goggles or safety glasses whichever is appropriate.

   Contact lenses are prohibited.

A properly selected respirator must be supplied when required by the plant's Respiratory Protection Program.

3. Personal protective equipment should be cleaned at least weekly. Gross contamination requires immediate cleaning and decontamination. Respirators must be cleaned and inspected daily . (A separate respiratory protection program is provided.)

4. 1., 2. and 3. above apply to all personnel who work in the plant including supervisors.

   Management, office personnel and visitors should be provided with protective equipment or clothing consistent with their activities while in the plants. Showers for transient visitors are not normally required. Exceptions to this general rule may be made by the plant manager, i.e., if gross contamination occurred.

   The plant is responsible to see that visitors are trained in the use of respiratory protective equipment if needed.

B. Work Practices

   1. Provide a change room for all employees occupationally exposed to pesticides.

a. Change rooms must be designated in two separate parts, i.e., the plant side (potentially contaminated), and the street side (uncontaminated).

b. Showers must be located between the plant and street sides.

c. Toilet facilities must be provided for personnel on both sides of the change house.

d. A floor to ceiling wall should separate the showers from the street side.

e. The design, and supervision by management must ensure that contamination of the street side does not occur.

2. Employees must wash their hands and face prior to taking breaks or lunch, or using toilets.

3. Supervised mandatory showers and a change to street clothing are required at the end of each work shift. Soap and towels will be provided to employees daily. No company supplied work clothing will be permitted to leave the plant for home laundering.

4. In the event an employee, his work clothing, or protective equipment become contaminated, the employee must shower immediately and obtain clean work clothes, and/or protective equipment.

C. Sanitation

1. The possession or use of food, beverages and tobacco will be prohibited where pesticides are being processed, transferred or stored.
2. A lunch room for the storage, preparation, and eating of food or drinking of beverages must be provided. The lunch room must not be in a processing, transferring or storage area.
3. A <u>separate</u> break area, also not in a processing, transferring or storage area, must be provided. This will be considered a contaminated area although all possible precautions must be taken to limit the contamination.
4. Light snacks, drinking and smoking will be allowed in the break area. Tobacco products may be kept there.
5. No eating, drinking or smoking will be allowed in processing, transferring or storage areas.
6. Drinking fountains should be outside of areas where processing, transferring or storage of pesticides is conducted.

D. Contamination Control

1. At a minimum, monthly swipe samples will be collected in at least two locations of the street side locker room, break area and the lunch area. The sampling locations should be rotated, varied and limited to locations where possible contamination would be expected.

2. If the results indicate contamination, the area in question shall be cleaned and decontaminated immediately and the cause of the contamination determined and eliminated.

3. Locker rooms, lunch rooms and break areas will be cleaned at least once daily.

II. PLANTS OR PLANT AREAS WITH A POTENTIAL FOR SIGNIFICANT EXPOSURE TO DESIGNATED CHEMICALS

Definitions:

a) " Designated chemicals" are any materials so identified by the Occupational Medicine Department, or by plant or division management with Occupational Medicine Department approval.

b) " Significant exposure" is any exposure in excess of limits established by federal or state laws, or by the Occupational Medicine Department.

APPENDIX B

PROCESS	Manufacturing and formulating
PROBLEM·	Malodorous trace compounds in effluent gas stream
SOLUTION	Powdered carbon injection into effluent, collection of carbon

The plant has effectively solved one of the significant problems associated with the phosphorous- and sulfur-containing pesticides destroying the odors of the numerous by-products and trace contaminants. These trace chemicals (mercaptans, etc.) have objectionable odors, and odor thresholds of often less than 0.1 ppm. The system used is described in U.S. Patent 3,798,877, and was observed in operation.

The basic principle involved is the injection of powdered carbon into the gas stream provision of sufficient contact time at the concentrations (of chemical to be removed and carbon) in air to permit complete adsorption, and subsequent collection of the carbon with the adsorbed chemical for safe disposal.

Figure 2 (I, II and III from the patent) shows various configurations of the system, and Figure 3 shows the system as installed at the plant. Although the system is intended to remove odors, it may be suitable for other trace chemical removal as well. Observations of the installed system confirm the patent claims, which were likewise substantiated by several field tests

The system is particularly intended for chemical removal from gas streams evolving from the operations of mixing or blending a liquid pesticide with an inert carrier dust (or other particulate substrate). The effluent stream will be composed of gases, vapors, and solid particles; the vapors and particles often require removal or concentration reduction to yield an emitted stream of acceptable quality.

General Conditions

The specific details of application will depend upon the conditions in each installation. Concentrations of the chemicals in the gas stream, humidity, temperature, particulate loading, and flow conditions will all affect the adsorption process. Likewise, the carbon particle size (and the size distribution of other particulate contaminants) will dictate the collection/separation device to be employed.

In general, the minimum amount of carbon should be approximately two times the amount that would be chosen if complete saturation of carbon adsorptive capacity were assumed. Larger amounts (rates of injection) are preferred,

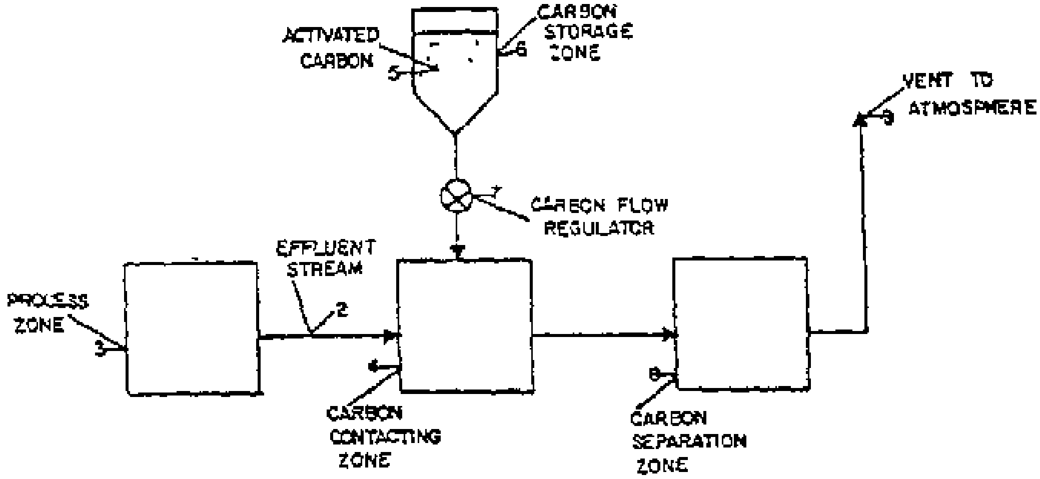

FIG I

Installation As Observed

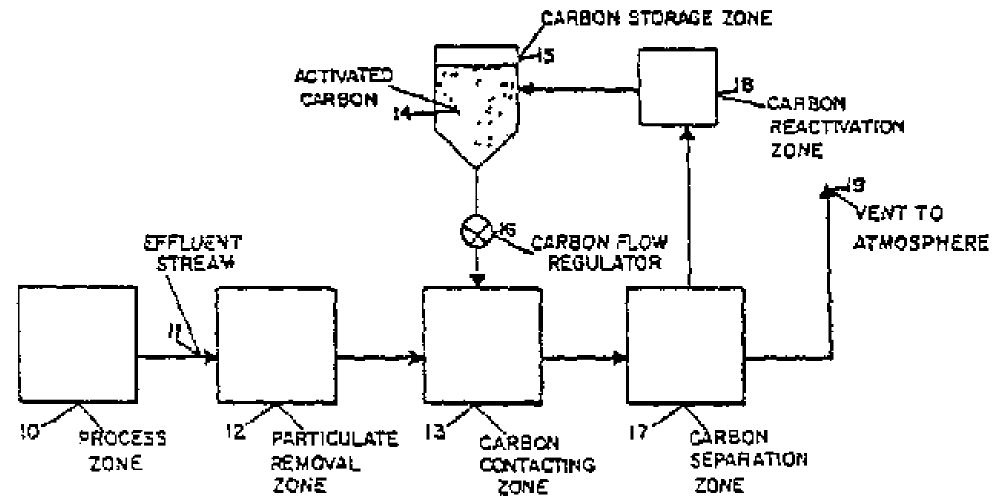

FIG II

Installation With Carbon Reactivation

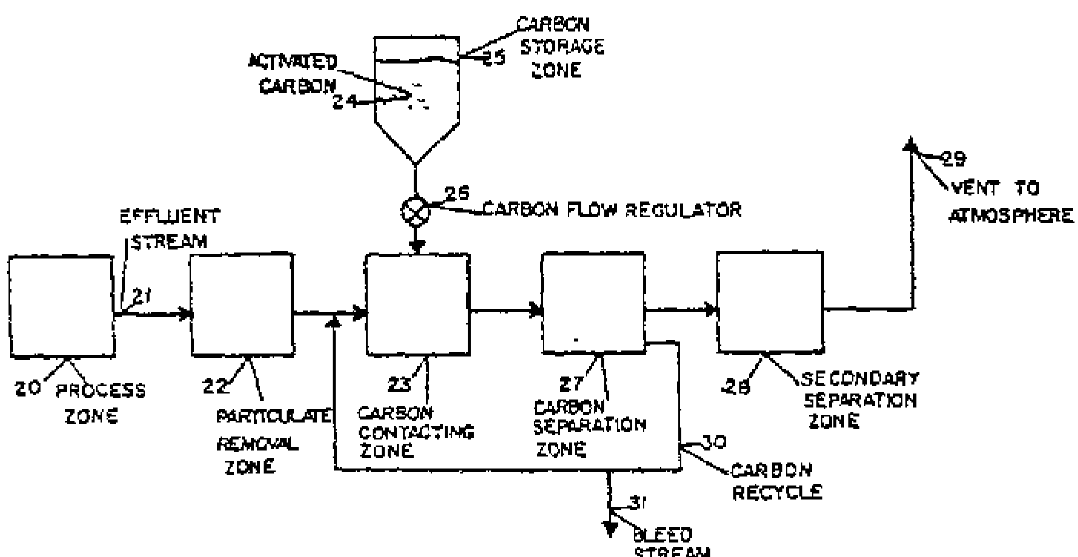

FIG III

Figure 2 Installation With Carbon Reactivation and Secondary Collector

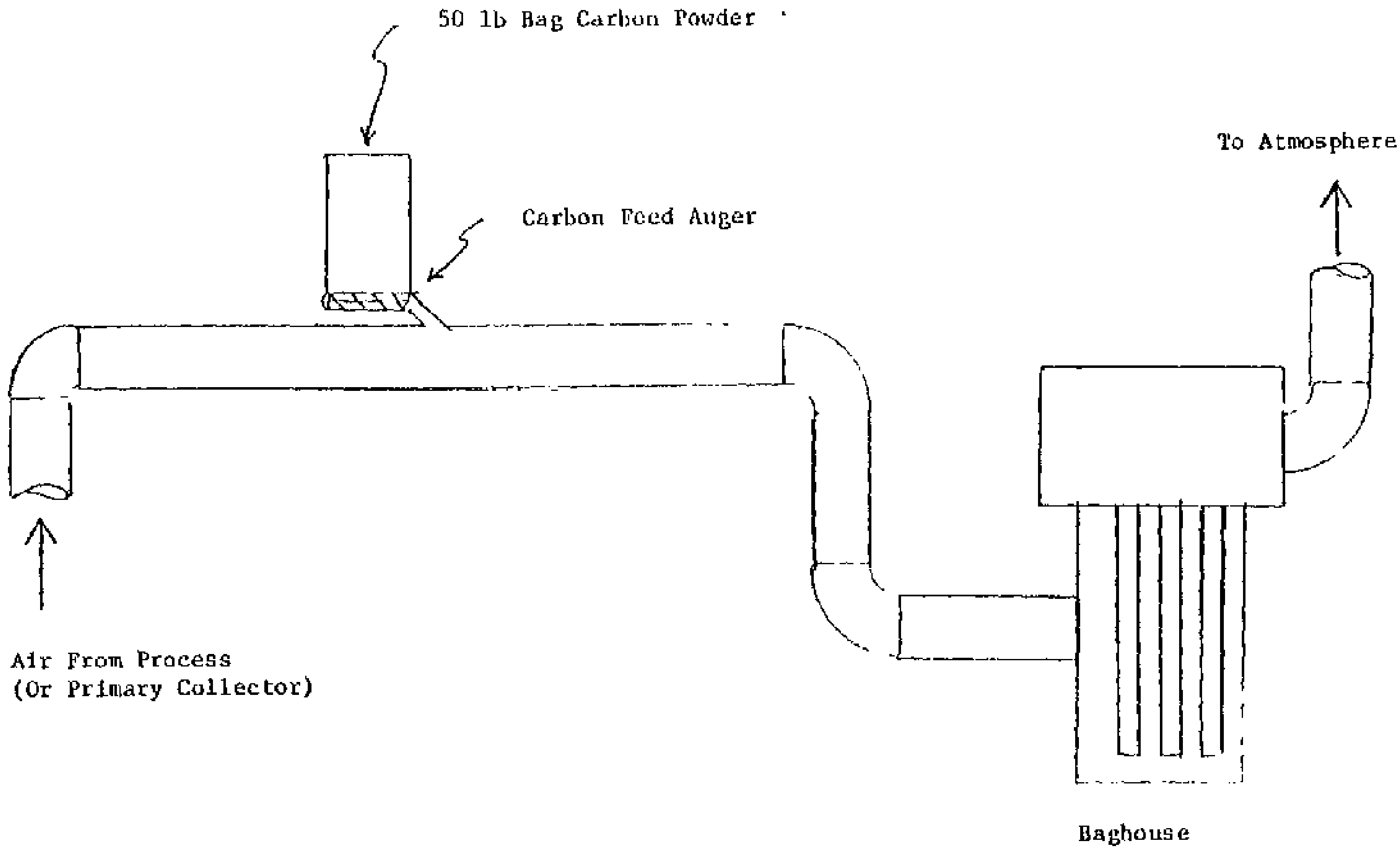

Figure 3 : System As Installed At Plant

and approximately 3-20 times the minimum amount appear to give optimal results. Usually from about 0.05 to 10 pounds per day per 1000 cubic feet per minute of gas to be deodorized is adequate. Contact times vary, depending upon conditions, but 0.2 seconds to greater than 15 seconds have been used. Any of a number of particle separation devices (filters, electrostatic precipitators, cyclones, other mechanical collectors, scrubbers) may be used to collect the carbon after contact. These will be chosen to facilitate further treatment (reactivation or disposal) of the carbon, as well as for collection efficiency. In the field installation observed, a filter baghouse was used.

Field Tests

Example 1

In the process of preparing a formulation of O, O-diethyl, O(2-isopropyl-4-methyl-6-pyrimidinyl) phosphorothioate on a dust carrier (Johns Manville Microcel®), various odorous by-products contained as traces in the technical grade pesticide may be released. In one installation, a gas stream of 8000 cubic feet per minute with dust loading equivalent to approximately 100 pounds per hour, was obtained from the various exhaust ventilation ducts. The gas stream leaving the bag filter dust collector had an unpleasant odor.

Two unsuccessful attempts were made to solve the odor problem. In the first of these, a catalytic combustion unit (platinum catalyst at 800^{o}F) was used No odor reduction was noted. In the second attempt, a liquid scrubber with 2% sulfuric acid was used. The odor, although somewhat reduced, was still objectionable. A liquid waste disposal problem (the sulfuric acid solution) was also created. The patent application then goes on to describe the next step

> A system incorporating the process of this invention was then installed. This system involved the passage of the effluent stream from the final mixing unit used in preparing the above described phosphorothioate through a primary dust collector which comprised a bag type, fabric filter apparatus having a capacity of 8,000 cubic feet per minute (cfm) and an air-to-fabric ratio of 7 cfm per square foot of fabric area. This device was used with a 12-ounce dacron sock as a filtering medium. As noted above, the gas stream entering this collector contained 2,213 pounds per day of particulate matter. The effluent stream emerging from this primary dust collector entered a conduit having an inner diameter of 20 inches and a length of 57 feet which led into a secondary dust collector. At a point 15 feet from the primary dust collector outlet, minus 325 mesh (U.S. Sieve Series) activated carbon sold under the trade name Darco S-51 was fed into the above described conduit at a rate of about 6 pounds per day. At the end of the conduit the gas stream was devoid of the unpleasant odor associated with the phosphorothioate. The gas stream entered a secondary dust collector.

Upon emerging from the secondary dust collector, which was a bag type, fabric filter comprising a 12 ounce, felted cotton sock having an air-to-fabric ratio of 1.5 cfm per square foot of fabric, the effluent stream which was being vented into the atmosphere was found to be devoid of the objectionable mercaptan type odor with only a light naphtha odor, which was readily dispersable within only about 30 feet from the vent, being emitted into the atmosphere so that it was completely undetectable at a distance of 200 feet from the vent. By contrast, when using either the catalytic burning unit or the liquid scrubber, as described hereinabove, at 1:1 dilution, the effluent being vented into the atmosphere could be detected at a distance of a one-fourth mile using a Model I-3 Barnaby Cheney Scentometer.

Comparable results, with respect to the reduction of odor, were attained by the application of the above described process to the effluent stream derived from the manufacture of formulations containing each of the following products:

1. The herbicide ethyl-N,N-di-n-propylthiocarbamate;
2. The herbicide S-ethyl diisobutylthiocarbamate;
3. The insecticide O-ethyl-S-phenylethylphosphorodithioate,
4. The insecticide O,O-dimethyl S-phthalimidomethyl phosphorodithioate;
5. The insecticide S-([(p-chlorophenyl)thio]methyl) O, O diethylphosphorodithioate;
6. The insecticide S-([p-chlorophenyl)thio]methyl) O, O dimethylphosphorodithioate;
7. The herbicide S-(,O-diisopropyl phosphorodithioate) of N-(2-mercaptoethyl) benzenesulfonamide,
8. The herbicide S-ethyl cyclohexyl ethyl thiocarbamate;
9. The herbicide S-propyl butyl ethylthiocarbamate;
10. The herbicide S-propyl dipropylthiocarbamate,
11. The insecticide tetra-n-propyl phosphorodithioate
12. The herbicide S-ethyl dipropylthiocarbamate;
13. The insecticide, O,O-diethyl S-(ethylthio) methyl phosphorodithioate; and
14. The herbicide hexahydro-H-azepine-hexahydro-h-azepine 1-carbothioate.

Example 2

Other field tests were also performed, and the patent application goes on to describe them:

The process of the invention is effective to remove combinations of odorous materials from a gas stream. the process of example 1 for blending O,O-diethyl O-(2-isopropyl-4-methyl-6-pyrimidinyl) phosphorothioate with "MICRO-CEL" was in operation. Several cans of a blend of O,O-dimethyl S-phtalimidomethyl phosphorodithoiate on "MICRO-CELL" were opened and placed in a dust collector and several drums of technical O,O-dimethyl S-phthalimidomethyl phosphorodithioate were opened and placed adjacent to the air inlet of a dust collector. About 8,000 cubic feet per minute of air was drawn through the system. The carbon feed to the adsorption zone was cut off. Within 15 minutes the characteristic unpleasant odors associated with both phosphorothioates were detectable in the gas at the outlet of the adsorption zone. The activated carbon feed was started at a rate of 20 pounds per day of -200 mesh Darco S-51 into the 20 inch diameter 57 feet long duct. In less than a minute the unpleasant odor as associated with the two phosphorothioates was undetectable at the end of the duct. The unpleasant odors associated with more than one composition can be simultaneously removed from the gas stream by the odor control method of the present invention.

Example 3

The apparatus of Example I was in service preparing a mixture of O, O-diethyl O-(O-(2-isopropyl-4-methyl-6-pyrimidinyl) phosphorothioate on "MICRO-CEL." About 8,000 cubic feet a minute of gas was entering the dust collector and odor control system. Darco S-51 activated carbon of a particle size minus 200 mesh (U.S. Sieve Series) was fed into the 57 foot duct which connects the primary and secondary dust collectors at a point 15 feet from the outlet of the primary dust collector at a rate of 9.6 pounds per day. The unpleasant odor associated with the phosphorothioate was not detectable at the entrance to the secondary dust collector.

The air stream was sampled at the discharge of the primary dust collector at the entrance of the secondary dust collector and at the exit of the secondary dust collector. The samples were analyzed by gas chromatography. The only significant peak in the chromatographic analysis was that of the phosphorothioate.

The O,O-diethyl O-(2-isopropyl-4-methyl-6-pyrimidinyl) phosphorothioate loading of the gas stream was as follows:

Outlet Primary Dust Collector--0.305 parts per million
Inlet Secondary Dust Collector--0.126 perts per million
Outlet Secondary Dust Collector--0.0216 parts per million

Although the loading of the O,O-diethyl O-(2-isopropyl-4-methyl-6-pyrimidinyl) phosphorothioate was relatively high at the inlet of the secondary dust collector, the unpleasant and obnoxious odor associated with the phosphorothioate had been removed from the gas stream.

The only significant peak which appeared in any of the gas chromatographs was that associated with the phosphorothioate. The components of the gas stream with the obnoxious odor did not appear in the gas chromatographic analysis. The most reliable method for determining the presence or absence of the obnoxious and unpleasant odor is by smell. The analysis indicates that the odorous materials are preferentially adsorbed from the gas stream since the amounts of the major component remained in the gas stream to a significant degree at the end of the adsorption zone where the gas stream enters the secondary dust collector. At this point the odor of the gas stream indicated that the obnoxious and unpleasant odors had been removed from the gas stream.

The apparatus of Example I was utilized to prepare a formulation of O, O-diethyl O-(2-isopropyl-4-methyl-6-pyrimidinyl) phosphorothioate. About 8,100 cubic feet per minute of air enter the dust collection and odor control system. Darco S-51 activated carbon of minus 200 mesh (U.S. Sieve Series) was fed into the 20 inch diameter duct at a rate of 14 4 pounds per day at a point 15 feet downstream from the primary dust collector. The air stream was sampled at the outlet of the primary dust collector, at the inlet of the secondary dust collector and at the outlet of the secondary dust collector.

The O,O-diethyl O-(2-isopropyl-4-methyl-6-pyrimidinyl) phosphorothioate loading of the gas stream was as follows:

Outlet Primary Dust Collector--0.52 parts per million
Inlet Secondary Dust Collector--0 24 parts per million
Outlet Secondary Dust Collector--0.016 parts per million

The gas stream at the outlet of the primary dust collector had the strong obnoxious and unpleasant smell associated with the phosphorothioate. The unpleasant and obnoxious odor was not present at the inlet to the secondary dust collector. The gas stream had a pleasant naphtha like odor at this point.

The loading of the phosphorothioate in the gas stream at the inlet to the secondary dust collector was near the level of the phosphorothioate in the gas stream at the outlet of the primary dust collector in Example III. The gas stream, however, did not have the unpleasant and obnoxious odor which was preseant in the gas stream at the outlet in Example III. The activated carbon preferentially adsorbed the materials which impart the obnoxious and unpleasant odors to the gas stream.

As stated above, observations at the plant confirm the effectiveness of the system. The system, as shown in Figure 4, utilized a BIF dust feeder, with a 1-inch I.D. variable speed auger to deliver the carbon into the ducts. The feeder is activated when air flows through the system. Efficiency of control can be determined from the data given in field tests 3 and 4 above. For example 3, the efficiency is $\frac{0.305-0.0216}{0.305} \times 100 = 92.9\%$;

for example 4, it is $\frac{0.52 - 0.016}{0.52} \times 100 = 96.9\%$.

It should be noted that other installations may exhibit greater or lesser effectiveness, depending upon specific local conditions.