

With heavy concentrations of smoke (which does not perform like a true vapor), it may be advantageous to use electrostatic precipitators ahead of the carbon filters.

Consider a high quality charcoal filter having a $\frac{1}{2}$ in. thickness of 6×10 mesh, and sufficient area so that the face velocity is about 40 fpm. The air after passing through such a filter is generally odor-free and the equivalent of outdoor air. Manufacturers rate the efficiencies of such adsorbers at approximately 95 percent. The efficiency might be higher than this, say 97 or 98 percent when the cell is first installed and may drop to about 90 just before the cell is reactivated or the activated charcoal changed. In most of the ventilating problems a 95 percent removal efficiency is sufficient to bring the odor level well below threshold and produce fresh air. Such a filter may have a pressure drop of about 0.2 in. of water.

An activated charcoal bed 1 in. thick rather than $\frac{1}{2}$ in. may have an average efficiency during its useful life of about 98 percent. It could start out at 99 percent and drop to as low as 90 percent just before the charcoal is changed. Such a cell would probably have a pressure drop of about 0.30 to 0.35 in. of water at standard velocities.

Everything else being equal, the service life (not initial efficiency) and resistance are proportional to the thickness of the activated charcoal bed. Commercial adsorber cells of the straight-through, factory-activated type are available with charcoal bed thicknesses from $\frac{1}{2}$ to 4 in. and the efficiencies, depending on conditions of operation, can vary from 90 to practically 100 percent. If the cells are reactivated frequently the adsorption efficiency can be maintained at a high level. Deep charcoal beds (frequently regenerated in-place) are used for very high concentrations such as found in process applications. The partial bypass types have efficiencies in the general range of 5 to 50 percent and the resistances to air flow generally lower than other types.

To purify 30 percent of the recirculated stream through a $\frac{1}{2}$ in. thick charcoal filter of the type just described will require that 30 percent of the air must be increased in pressure 0.2 in. of water, by a fan, or the total air stream must be increased in pressure by this amount and 70 percent throttled through bypass valves. Another way to solve the same problem at lower pressure drop is to use a partial bypass type of filter having an efficiency of 30 percent. This might be accomplished with a pressure drop of about 0.1 in. of water rather than 0.2 in. A third way to accomplish this without causing the main system fan to operate against increased pressure is to mount a self-contained unit (charcoal filters and blower) in the fan room or plenum. This unit can be selected to continuously purify air at a sufficient rate to maintain the air purity at the desired level.

The use of activated charcoal is acceptable under most governmental regulatory codes.⁴ The reduction in outdoor air ventilation requirements and its economic aspects have been treated in the 1961 GUIDE AND DATA BOOK, Chapter 10 and elsewhere.^{1,10}

ODOR MASKING

The principles of odor masking have been stated in Chapter 10 of the 1961 GUIDE AND DATA BOOK. Odor masking is the process of eliminating the perception of one odor or a group of odors by superimposing another odor or a group of odors to create a new odor sensation, preferably pleasant.

Odor control chemicals used for masking purposes are those aromatic chemicals and their by-products which are derived chiefly from synthetic aromatic chemical manufacture. A

masking agent does not alter the composition of pre-existing odor. When superimposed it is selected by the nasal perception apparatus as long as there is sufficient presence of the masking odor in the air stream.

Organic odor control chemicals are numerous. Each type differs, since some may be malodorous and others sweet or sour, fresh or musty. Examples are vanillin, methyl ionones, eugenols, benzyl acetate, phenylethyl alcohol, heliotropin. Only by selected manufacture and measurement is it possible to obtain an odor control chemical suited to a particular masking or odorization problem.

Many odor nuisances fall into similar patterns for similar operations in the same industry, for example: odors from a sulfate pulp mill, from rayon processing, asphalt blowing, and many of the chemical processes. These odors enter air conditioned spaces and office areas by infiltration. Cooking and smoking odors diffuse throughout a building. In many cases, where the basic character of the operation is known, a sample of the odor effluent is not necessary to establish a suitable odor masking or modification compound.

Even though all normal people can perceive odors and many people find some odors agreeable, odor masking (and in its turn, odor counteraction) is not a field for amateur experimentation.

People suffering from brain lesions, injured olfactory nerves or obstructed nasal passages may be anosmic. Substances of different chemical constitution may have similar odors. Quality, as well as the strength of the odor, may change on dilution. The sense of smell is rapidly fatigued. Fatigue for one odor may not affect the perception of similar odors.

Formulation of a preferred odor control medium requires delicate olfactory analysis and technical experience. Completed formulation must include, in addition to maximum odor strength and optimum odor quality, special properties of chemical stability, lasting power, and physical form.

How to Apply Compounds

In comparison with the laboratory experience required to formulate odor masking compounds, application is relatively simple. For household purposes and sanitary facilities, simple vaporizers may be used.

For certain processes, such as digester operation in the

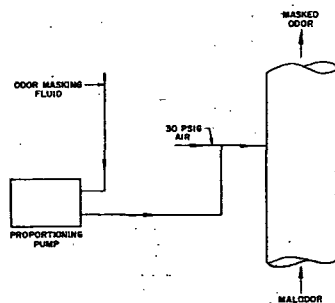


Fig. 2 Injection of Masking Agent in Duct or Exhaust Stack

Odor Control

kraft sulfate process, or cooking meat scraps and bones in rendering plants, odor masking compounds may be added directly to the product in process. The trend is, however, toward adding the masking compounds automatically with proportioning pumps. Concentrations may range from 10 to 50 ppm based on the weight of the process charge under treatment.

Odor masks may also be applied by air or pressure atomization (through properly designed spray nozzles) of a dilute dispersion of the material into the duct from which malodors are normally discharged as shown in Fig. 2. If the odor masking agent is water soluble it can be diluted with water to most practical dilutions, usually 1 to 5 percent. Injection is usually made at a point well below the top of the stack to assure good mixing with the effluent vapors.

An oil-base masking agent may be sprinkled along the shoreline of a lagoon or poured on the liquid surface of the lagoon where it will spread most readily. Normal evaporation under the heat of the sun vaporizes the mask continuously along the entire area.

Pros and Cons of Masking

Masking compounds should never be used to mask or cover up a toxic concentration of gas. Many odorous compounds such as hydrogen sulfide are highly toxic and nonrecognition of the odor may expose the individual to sufficient concentration to be fatal.

Advantages of the use of masking agents are minimum or no capital investment for equipment; ease of application; relatively low cost in comparison with mechanical equipment; and immediate availability for known odor nuisances.

Extreme care must be used in handling. Spillage or contact on hands or clothing may create objectionable odor concentrations. Even pleasant odors may be objectionable in high concentrations. For this reason odor masking compounds must not be applied in so great a quantity that the resultant combination may itself be offensive or objectionable.

Control Via Odor Masking

In preparation for odor masking control these basic steps may be taken:¹¹

1. Make an analysis of the toxic materials or lack of toxic materials in ppm and total volume (cfm) from stack exhausts. Check with the local public health officials or air pollution officers to determine whether dispersal of these materials is well below the minimum permissible level in the surrounding area.
2. Do not attempt to formulate masking compounds unless you have had considerable and lengthy experience in odor chemistry.
3. Establish quantities of material used in process, particularly the odorous materials, and temperatures of process and stack effluent. Call in a competent manufacturer of masking compounds and disclose as much information regarding the process as permissible. Have him observe the malodors from the exhaust and in the surrounding area.
4. If the masking compound is to be used as an additive, establish in the laboratory that the addition has no effect on the process. If the masking compound is to be applied to the exhaust, it is advisable to perform a laboratory or pilot-plant experiment with the product to establish ratios which will not result in an intense effluent. Determine that the odor of the final combination will not be offensive due to odor incompatibility.
5. Install equipment as prescribed by the masking compound manufacturer. This is ordinarily a simple installation that can be made by plant personnel and usually involves only a source of air and a calibrated spray nozzle.
6. By means of an odor jury make area surveys over a period of several days. Take into consideration known factors regarding air inversions, topography, and wind movements. Care should

be used in building up to the required concentration, since an excess may result in complaints in the surrounding area regarding new odors.

ODOR MODIFICATION

In so-called odor counteraction¹² certain pairs of odors in appropriate relative concentrations are antagonistic. When the two are sniffed together both odors are diminished.

A number of investigators¹³ have found it possible to compensate the olfactory effects of various chemicals to a point of total odor disappearance or significantly close to the point of total odor disappearance. It is a demonstrable fact that in the group benzene, toluene, xylene, pseudocumene and durene, combinations in the correct proportions can be produced which are almost odorless. Many materials are thus available for odor counteraction, including the essential oils.

Air Conditioned Spaces

Odor modification was first applied to domestic households to eliminate odors from products such as oil cloth and rubber, polishes, wax, paints, inks and insecticides. These are all antisocial from an odor standpoint. Attempts to dominate these odors by the use of sassafras, wintergreen, citronella, pine, lavender and other compounds were not satisfactory. Commercial use of odor modification thus developed in this field. Since air freshness was desired, instead of recognizable specific odor types, odor modification with a sense of freshness was developed by introducing traces of the chemicals found in outdoor plant-life.

Industrial Areas

Although an industrial process may be simple, odors coming from the process may be a complex group. It is unusual to obtain a specific odor from an industrial process stack. Even when this is the case the odor may combine with transient odors in the surrounding atmosphere. For this reason industrial odor counteractant formulations, although designed for specific odor descriptions, may contain complex groups of odor modifiers.

There is no chemical method known for the determination of the effectiveness of odor modifiers. Effectiveness can be determined only by actual odor perception. In the last analysis this is the criteria for the effectiveness of any odor abatement method.

Applying Modifiers

Odor modification deals with molecules of odor. For practical purposes an odor is always a gas molecularly dispersed in air in sufficient concentration to be above the threshold level of perception. For this reason modifiers are most effective when vaporized and combined with the air stream by molecular dispersion.

Odor modifiers are vaporized by atomizing the modifier into the air movement or stream by means of a calibrated atomizing nozzle. These vaporizing points are usually located in or near the source or exhausts but may also be located elsewhere.

Modifiers mix with the odorous air stream by molecular dispersion and air movements and are designed to follow the physical behavior pattern of the odorous elements. Some odorous elements disperse beyond the limits of perceptibility rapidly, others are tenacious and do not disperse horizontally or vertically so quickly, thus creating special control problems.

Odorous discharge from kraft sulfate pulp mills, probably due to some microscopic particulate formation, continue