Odor Control

Revised 2018

Introduction

Incidents of odor transfer among various foods stored in refrigerated and frozen warehouses are not infrequent. In fact, the most frequent inquiry to IARW and WFLO over many years has involved odor transfer problems. Odors emanating from foods such as meats, fish, shellfish, cheese, fruit, onions, garlic, coffee beans, and many vegetables, as well as from soap flakes, tobacco, smoke, alligator hides, batteries, and various chemicals have resulted in many cases of flavor damage to other stored products. Substantial economic loss, either from product deterioration or claims, can occur when odor is transferred from one stored commodity to another.

Odors associated with various foods and many non-food items stored in PRW's are volatile organic compounds (VOC's). These compounds are transferred either through air currents or diffusion from their source, and are absorbed or adsorbed by other foods. Odor absorption is especially prevalent with products high in lipid content. As such, cheese or ice cream products can begin to taste and smell like fish, potatoes or other uncharacteristic and undesirable products.

Foods that are known to be significant sources of odorous VOC's include, but are not limited to: potatoes, licorice candy, onions, cheeses, oranges, shallots, apples, blueberries, pears, cabbage, carp, coffee beans, beef jerky, cod fish, smoked meats, crayfish, chives, garlic, ginger root, herring, hops, paprika pods, pet food, pickles, rose bushes, sausage, shrimp, squid, strawberries, tuna fish, and turmeric.

Foods that are known to be particularly vulnerable to odor transfer from other foods and non-food items include: carrots, cheeses, ice cream, nuts, dried fruit, candies, pecans, cookies, meat products, corned beef, cranberries, butter, bagels, French fries, ice, ice cubes, peppers, nonfat dry milk, margarine, raisins, kiwifruit, corn-on-the-cob, and luncheon meats.

Classifying commodities by odor incompatibilities is a challenge, but the following characterizations may be useful:

- Odors from apples or pears are absorbed by cabbage, carrots, celery, figs, onions, and potatoes;
- Celery also absorbs odors from onions and carrots;
- Odor from leeks is absorbed by figs and grapes;
- Odor from green onions is absorbed by figs, grapes, mushrooms, rhubarb and corn;
- Odor from dry onions is absorbed by apples, pears, celery, and citrus;
- Odor from peppers is absorbed by avocadoes, green beans, and pineapples;
- Eggplants absorb odor from ginger;
- Pineapples absorb odor from avocadoes;
- Citrus fruits may absorb odors from any strongly scented vegetable.
- Apples and pears may acquire an earthy taste and odor if shipped with potatoes.

- Odors from apples, citrus, onions, pineapples, and fish are absorbed by dairy products, eggs, meats, and nuts.

Odor Control by Ventilation

Odor within an enclosed space can be treated by ventilation with ambient air from outside sources. Effective room ventilation can even be carried out within refrigerated spaces as long as the duration of ventilation is relatively brief and the temperature within the space does not increase more than a few degrees. However, this short-term solution to deal with odor inside the refrigerated space is usually not completely effective or desirable, either because the ventilation duration is too short or because the odor recurs from its source in a relatively short time.

Unwanted odors can be removed from spills on shipping and receiving dock areas by treatment of the odor sites with oxidative chemicals such as chlorine (1 part laundry bleach to 9 parts water) followed by water rinsing and ventilation. This option is not available for use in warehouse spaces where the temperature is below 32°F (0°C) or where there is no floor drain.

Packaging for Odor Transfer Control

Many food and non-food products are enclosed in high barrier packaging materials such as metal cans and drums, glass or plastic jars, or various types of polymeric flexible packages that prevent the passage of VOC's. As long as these packages remain intact, odor transfer through the package is virtually impossible. Even though some flexible polymeric packaging materials provide a lesser barrier to the passage of VOC's than others, such as low density polyethylene (LDPE), they are all reasonably effective. However, broken or torn high barrier packages allow VOC's to enter the warehouse environment. It should be noted that many products, whether stored above or below their freezing points, are not enclosed in high barrier packaging materials. In these instances some action must be taken to eliminate VOC's from the warehouse space and thereby preclude the potential for odor transfer among stored products.

Activated Carbon Odor Control

An effective option for removal of odor chemicals (VOC's) on a porous, relatively inert material is through the use of activated carbon. Activated carbon is a microcrystalline carbon that has been manufactured to produce extensive internal porosity, thereby providing an extensive surface area with the capability of adsorbing VOC's from the air.

VOC molecules are attracted to and accumulate onto the surface of activated carbon. One pound of activated carbon has a surface area of about 125 acres, and one kg has a surface area of about 112 hectares. As a result of this extensive surface area, activated carbon has the capability to adsorb large amounts of organic odor molecules from the air. It should be noted that when air containing odorous VOC's is passed through a container of granular activated carbon, the VOC's are attracted to and held onto the surface walls of the micro-pores. Air leaving a correctly operated container is essentially free of VOC's and is therefore odor free.

What is Activated Carbon?

Activated carbon is manufactured from coal and other organic raw materials with high carbon content such as animal bones, wood, nutshells, fruit pits, and rice hulls. The raw material is crushed, mixed with a binder, re-compacted, and then re-crushed into granules of 1-5 cm^3. The granules are heated in a high temperature furnace at 1,112°F (600°C) in the absence of oxygen to produce a char. The char is “activated” by the action of oxidizing agents such as steam, air, or carbon dioxide at temperatures of 1,470-1,650°F (800-900°C). The activation process produces a pore structure inside each granule that is an extensive network of labyrinth-like tunnels. The pores developed in the carbon granules range in size from 0.001 to <0.000001 cm (4 x 10-4 to <4 x 10-7 inch). Another term for activated carbon is activated charcoal.

Characteristics of VOC Adsorption from Warehouse Air

When air laden with VOC’s is passed through a container packed with activated carbon, called the adsorbent, the VOC molecules, called the adsorbate, adhere to the internal surfaces of the adsorbent. If an insufficient amount of adsorbent is present some odorous VOC molecules will remain in the air and be returned to the warehouse space. This can be corrected by adding more adsorbent or by slowing the rate of passage of the air stream through the activated carbon. There is some heat gain in the air leaving the container of adsorbent. The degree to which VOC’s are removed from the air stream is influenced by a number of factors, including:

- The nature of the activated carbon in terms of granule size, porosity, and carbon source
- The quantity of activated carbon present
- The concentration and chemical nature of the VOC’s in the air stream
- The flow rate (ft^3/min or L/s) of air through the activated carbon
- The temperature of the air stream
- The degree to which the surface area of the activated carbon is saturated with adsorbate

Operation of Activated Carbon Air Filter Systems

Most food odors are easily removed from the air in a warehouse by activated carbon, so a good grade of standard carbon should work quite well. A special kind or grade of carbon is not necessary. Coconut shells are a satisfactory raw material for use to manufacture granular activated carbon for removing VOC’s from air. The key to successful removal of odor chemicals from warehouse air is to design an effective system to carry odor-laden air through an appropriately sized activated carbon adsorber.

Adsorber systems vary in diameter from 24 to 144 in (61 to 366 cm) and in height from 35 to 138 in (89 to 351 cm). They contain from 150 to 11,875 pounds (68 to 5,386 kg) of granular activated carbon, and airflow rates through the systems vary from 100 to 10,000 ft^3/min (47 to 4,700 L/sec). Transportable adsorber systems containing from 100 to 5,000 pounds (45 to 2,270 kg) of activated carbon are available as standard items from several manufactures, and can be purchased or leased.

The time required for activated carbon to become saturated with VOC's varies considerably from a few weeks or months to a year or more. Once the activated carbon in a system becomes saturated it will no longer remove odor chemicals from air passed through it. In this case the system supplier can remove the spent carbon and replace it with either reactivated or virgin material. Suppliers can reactivate spent carbon for reuse or it can be discarded.

Activated Carbon System Suppliers

Commercial suppliers can easily be found by using various Internet search engines, using key words such as "Activated Carbon Odor Control."

Ozone Odor Control

Ozone is a highly reactive oxidative molecule with the formula O_3. It controls odor from VOC's and other chemicals in the warehouse air by oxidizing them to non-odorous components. Because ozone is unstable, it must be generated onsite using an ozone generator. Ozone generators have been used successfully to eliminate ammonia odor in warehouses. However, because of the potential for ignition and/or an explosion, it is necessary to locate ozone generators outside the room or space where ammonia vapors are present and conduct the ozone into the room or space through a hose or duct.

Ozone can hasten the elimination of ammonia odor from warehouses and corrugated shipping cases at ambient temperature; however, ozone is less effective at freezing temperatures. Ozone also causes objectionable flavor changes to many foods, including those high in lipids, if they are not in good barrier packages. Even low levels of ozone will cause oxidative rancidity to develop in high lipid foods without protective packaging.

It should be noted that ozone is toxic to plants and animals. Ozone also degrades rubber and corrodes many metals. According to the United States Occupational Safety and Health Administration (OSHA), the maximum allowable exposure for people during an 8-hour period is 0.10 ppm. Exposure to ozone concentrations between 1 and 100 ppm can cause asthma-like symptoms. Short exposure to ozone concentrations above 100 ppm can cause throat irritations, hemorrhaging, and pulmonary edema. Therefore, it is most important that people not be exposed to ozone concentrations in excess of 0.10 ppm for any significant duration.

In 1987 the TRREF (the precursor to WFLO) Ozone Committee recommended that ozone only be considered for odor removal in warehouses devoid of people and food products to avoid the risks of off-flavors in food and safety hazards to people.

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