Minimizing Odor Generation

Manure removal management and housecleaning

Manure, wet feed, and other products that could produce odors in buildings should be removed regularly. This list includes dust buildup both on the inside and on the outside of buildings but especially inside animal housing facilities. Odor from floor surfaces will be reduced if the floors are kept clean and dry.

Control of odors from under-floor manure pits depends on the type and length of manure storage. Manure stored longer than five days will generate more offensive gases. Undiluted liquid manure has a large potential for odor production. Therefore, to reduce odors from shallow gutters with pull plugs, the manure should be removed at least once a week. Often, weekly cleaning is not a standard practice but may become so if odor control is the main objective.

One method of shallow gutter management to enhance odor control that is still being debated is the practice of using recharge water, which is required for weekly cleaning of pull-plug systems. Some facilities use clean recharge water, some recycle recharge water, and others do not recharge their shallow gutters. Anecdotal evidence suggests that using clean or "treated" recycled recharge water may reduce odorous emissions compared to using no recharge water. These reductions are likely to be very dependent on the quality of recharge water.

Summary. The potential for odor production can be reduced by instituting good housecleaning and management practices for the manure handling system in the animal housing. The amount of odor reduction is not well documented and is difficult to assess, but most experts think that odor reduction should be measurable and noticeable by both workers and those living near the housing facilities.

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Bedded systems

Using solid manure systems rather than liquid manure systems is generally considered to reduce odor. Although gases and dust are emitted from solid or bedded systems, most people feel that odor from bedded systems is less objectionable than the odor from liquid systems. Using bedding/dry manure systems for animals is generally considered to be more environmentally acceptable from both water quality and outdoor air quality viewpoints.

Anecdotal evidence suggests that organic bedding such as straw, cornstalks, compost, wood chips, or newspaper may reduce odor emissions. European research supports the use of some type of bedding (especially sawdust) to reduce odor generation/levels in buildings and subsequent odor release or emission (Nicks et al. 1997). Relatively small bedding levels may be enough to have an effect on odor generation/emission. Until liquid systems were adapted, primarily for convenience, bedding had been used for livestock production for generations. Many dairy and poultry facilities still use dry or solid manure systems.

Hoop structures have recently become popular for a few swine and dairy producers, in part due to their odor control effectiveness. They feature a deep-bedded pack system using straw or other crop residues to provide animal comfort and soak up manure liquids. Bedding availability is crucial for solid manure systems except for high-rise layer houses. Hoop structure bedding requirements for finishing swine are estimated to be 200 pounds of baled cornstalks per pig marketed. MidWest Plan Service (MWPS) publications

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AED- 41 and -44 give details on using bedded hoop structures for swine production.

Summary. Using solid manure systems rather than liquid manure systems is generally considered to produce less odor. Controlled studies to quantify odors from the two different systems are underway, but most people feel that odor from bedded systems is less objectionable than odor from liquid systems. Manure systems that use bedding for any animal species seems to reduce odor. Many modern layer facilities are high-rise units that store the manure as a solid product. Broilers and turkeys use litter systems effectively.

Vegetable oil sprinkling

Airborne dust, a common problem inside animal housing facilities, has been linked to both human and animal health concerns. Since suspended dust particles can and often do absorb toxic and odorous gases, the reduction of the airborne dust concentrations inside buildings lowers the odor and gas emissions from these animal housing facilities. Research has shown that sprinkling various types of vegetable oil inside pig buildings reduces the indoor airborne dust levels.

Description. Detailed information on sprinkling vegetable oils in pig barns is given in the MWPS publication AED-42 (Zhang et al. 1997). Oil can be applied manually with a hand-held sprayer or automatically with a permanently installed sprinkler system. Once-a-day application is recommended. It is important to operate the oil-sprinkling equipment so the droplet size is neither too large, which results in poor distribution, nor too small (aerial mist), which may be a health hazard for the animals. Operating the spray nozzles within pressure and temperature limits of the suggested vegetable oils can control droplet size. The MWPS publication gives the recommended levels for such oils as canola, corn, flax, soybean, and sunflower.

Research data. Oil-sprinkling research (Takai et al. 1993) indicates reductions in dust levels, and in one case (Zhang et al. 1996), reduction of odorous gases like hydrogen sulfide and ammonia. Dust levels were lowered 80%, while hydrogen sulfide and ammonia concentrations were reduced 20% or 30%, respectively, in these studies.

Research conducted at the University of Minnesota (Jacobson et al. 1998) showed total dust concentrations were reduced considerably by oil sprinkling (Figure 41-1). Dust levels in the oil treatment room were about 40% of the dust levels in the control room. Respirable dust levels (the fraction that reaches the human lung), however, did not follow this trend, showing similar concentrations for both the control and treatment rooms. Reasons for the inconsistent results are difficult to determine but may be related to the fact that once-a-day sprinkling may only reduce the large particulate (feed and fecal) materials and not smaller airborne particles.

Also during this same study, an average odor reduction of 50% was seen in an oil-treated pig nursery compared to an untreated control pig nursery (Figure 41-2).

Oil sprinkling in the pig nursery barn did not have the same effect on individual gas concentrations. Hydrogen sulfide levels were reduced about 60% in the rooms sprinkled with oil, but ammonia levels were unaffected by the oil treatment.

Challenges. Compared to the control room, extra labor was needed to clean the oil treatment room after each group was moved out of the respective buildings. Producers may want to add a “presoak” segment to their cleaning protocol to aid the cleanup of surfaces in these facilities, which will lead to additional wash time. To be used at the farm level, an automated system is needed to deliver the oil in the building, as opposed to using hand-held sprayers. Existing presoak sprinkling systems may potentially be modified to accomplish this with the aid of timers, oil injection pumps, and solenoid valves.

Summary. As outlined in the MWPS publication AED-42, daily sprinkling of very small amounts of vegetable oil inside an animal facility reduced the odor, hydrogen sulfide, and total dust levels of the air inside the barn and in the exhaust ventilation air. Oil sprinkling was less effective in reducing ammonia concentrations or respirable dust levels inside the treated barn.

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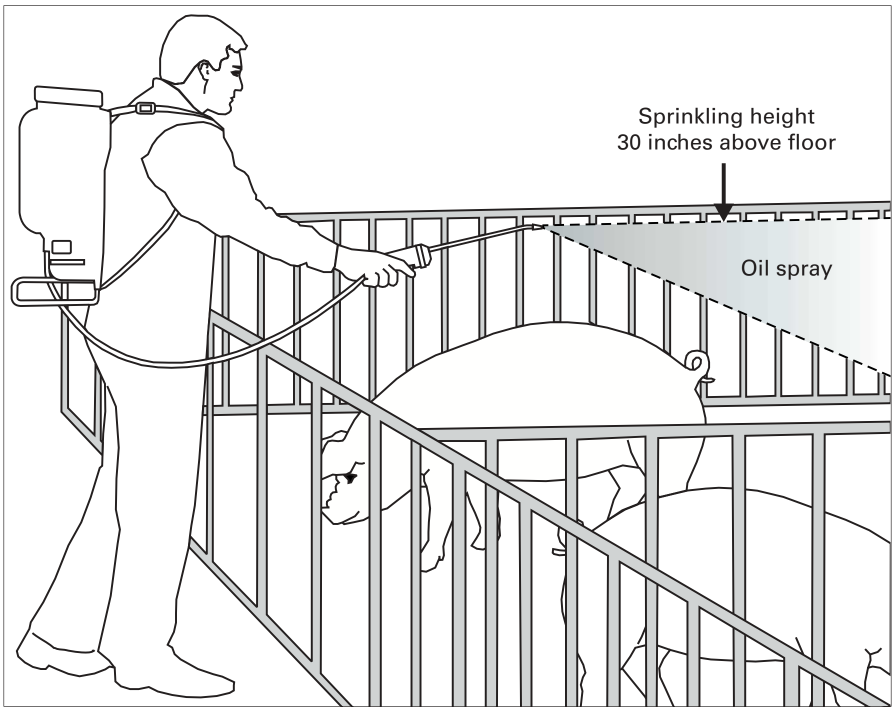

Figure 41-1. Applying oil in oil treatment room.
Source: MWPS, AED-42.

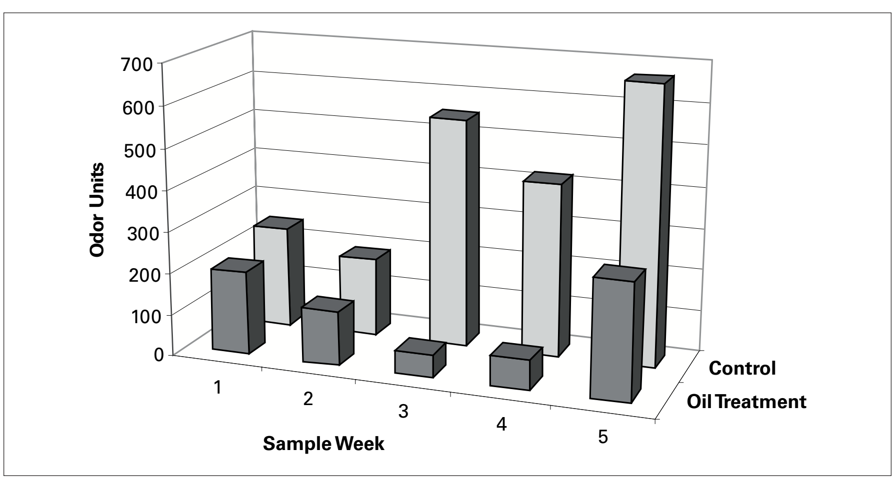

Figure 41-2. Odor levels in rooms.

Using water to scrub odorous dust, ammonia, hydrogen sulfide, and other gases from the airflow of swine building ventilation fans can be an effective method of controlling odor.

Washing walls and other wet scrubbers

Using water to scrub odorous dust, ammonia, hydrogen sulfide, and other gases from the airflow of swine building ventilation fans can be an effective method of controlling odor. Many industrial air pollution control systems use sprays of water to scrub dust, ammonia, sulfur oxides, and nitrous oxides from various polluting air streams. In a wet scrubber, an alkali is usually added to react with acidic pollutants.

A wet scrubber design that recirculates most of the water through the system has been tested in North Carolina (Bottcher et al. 1999). This design involves a wetted pad evaporative cooling system installed in a constructed wall about 4 feet upwind of ventilation fans and downwind of the pigs in a tunnel-ventilated building (Figure 41-3).

Measurements taken by Bottcher et al. (1999) show that the system reduces total dust levels over 60% at low ventilation rates but only by about 20% at a high airflow rate typical of maximum hot weather ventilation. Although the changes in odor levels across the wetted pad scrubber were not as great as desired at the high ventilation rate, the data does indicate a modest odor reduction, consistent with the dust reduction. These results agree with other observations that dust removal from swine building airflow is associated with odor reduction. The wetted pad wall also reduced ammonia levels in the ventilation airflow by 50% at low ventilation rates and by 33% at medium ventilation rates.

Summary. A wet scrubber can reduce dust and gases. Wetted pad wall installation costs are approximately $5.70 per pig space for an 880-head finishing building (Swine Odor Task Force 1998). The main operating cost is the 1-hp water pump, which will cost about $600 annually. The wetted pad wall does not impose a significant airflow restriction on the building fans. Maintaining adequate airflow is important if a healthy indoor environment is to be provided for the animals in warm weather.

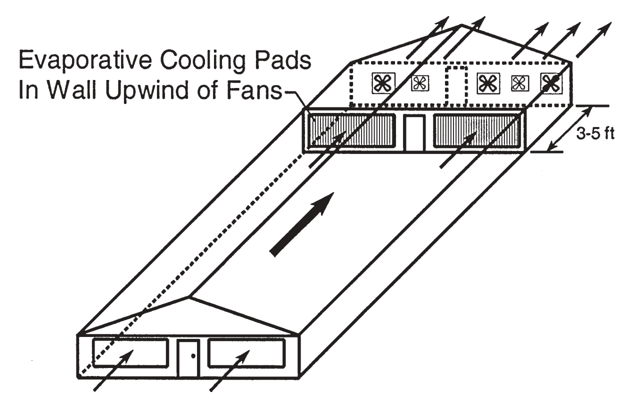

Figure 41-3. Evaporative cooling pad installed as a wet scrubber in a tunnel-ventilated swine building.
Source: Bottcher et al. 1999.

Chemical additives

In some instances, chemical additives are an option for odor or gas emission control. One application where additives were shown to be effective is the addition of alum to poultry litter. Moore et al. (1995) reported on a number of products that reduced ammonia volatilization from poultry litter, including alum, which provided a 99% reduction in ammonia volatilization when 200 g/Kg (20%) was added to the litter in broiler houses. Many other additives for both liquid and solid manure are on the market. A recent laboratory study tested 35 different manure pit additives (NPPC 2001) and found that only four products reduced odor by a 75% "certainty" level. Approximately 10 products reduced H_2S by either a 95% or 75% certainty level while 12 products lowered ammonia by the same percentages. Until the mechanisms for the various products are understood so reliable performance can be predicted, the additional costs for additive products may be hard for producers to justify.

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Ozonation

Description. Ozone is a powerful oxidizing agent and a very effective natural germicide. Ozone high in the atmosphere protects the earth from solar radiation. At ground level, however, the gas can be toxic at high levels. The current OSHA permissible exposure limit for ozone is 0.1 part per millon (ppm) for an 8-hour, time-weighted average exposure (OSHA 1998).

Ozone has been used to treat drinking water on a municipal scale since 1906, when it was installed in the treatment facilities for the city of Nice, France (Singer 1990). More than 2,000 water treatment works, primarily in France and other European countries, now use ozone for disinfecting, taste, and odor control of water supplies (Tate 1991). Currently, about 100 water treatment plants in the United States and Canada use ozone (Droste 1997).

Ozone generators are sold to "freshen" the air in offices and industrial facilities. A number of commercial ozone generators are currently being sold as residential air-cleaning devices.

The molecular arrangement of ozone is three atoms of oxygen (O_3). Ozone is unstable and reacts with other gases, changing their molecular structure. At low concentrations of 0.01 to 0.05 ppm, ozone has a "fresh or outdoor smell" associated with it. At higher concentrations, it begins to smell like an "electrical fire." The decomposition of ozone to oxygen is very fast. The half-life of ozone can reach 60 minutes in a cool, sterile environment and is near 20 minutes in typical conditions. In dusty animal houses, however, it may be much less. The most common products of the complete oxidation process are water vapor and carbon dioxide. Ozone reacts with and oxidizes most organic material. Thus, the relatively high level of indoor odors and dust in livestock buildings, the ability of ozone to oxidize pollutants, and the potential for ozone to be rapidly depleted continue to make the ozonation of indoor air an attractive but controversial technology for reducing emissions from animal facilities.

Application in animal facilities. The American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)(1989) determined that ozone is **not** an effective means of eliminating odors in ventilated air inside of buildings, but several ozone systems are on the market, and some are being tested on livestock farms with encouraging results.

In a 16-month experiment, Priem (1977) found that ozone (at concentrations up to 0.2 ppm) reduced ammonia levels in a swine barn by

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50% under winter ventilation conditions and by 15% under summer ventilation conditions. Researchers at Michigan State University reduced odorous compounds and disease-causing bacteria by treating swine manure slurry with high concentrations of ozone (Watkins et al. 1996). In this study, ozone was bubbled directly into fresh and stored swine manure in a continuously stirred batch reactor. Ozone concentrations of 1, 2, and 3 mg/l were used. Olfactometry determinations showed a significant odor reduction in ozonated manure samples in comparison to raw and oxygenated samples. More specifically, hydrogen sulfide concentrations were reduced slightly, while sulfate concentrations concurrently increased.

Researchers at North Carolina State University are evaluating a commercial ozone air treatment system in a tunnel-ventilated swine-finishing house at safe ozone levels for odor and dust reduction (Keener et al. 1999, Bottcher et al. 2000). Ozonation decreased ammonia levels 58% and total dust 58% compared to the control building, both at high ventilation rates. The concentration of dust particles with optical diameters less than 1 mm were lower in the ozonated house than in the control house. However, an olfactometry panel did not measure significantly different levels of odor parameters in the air samples from the ozonated and the control buildings. The reason for the difference between field observation and laboratory evaluation is still being investigated. More testing is needed before the ozonation of lagoons or of the air inside swine facilities can be recommended.

Summary. A limited number of published studies has evaluated the use of ozone for odor reduction in animal production facilities. Ozonation can potentially reduce odors in livestock facilities by killing the odor-producing microorganisms and by oxidizing the odorous metabolites. When oxidized, most compounds are reduced in odor intensity.

Diet manipulation

Nutrition may become one of the most important means of reducing emissions from livestock and poultry facilities. Research has begun to focus on the effect of diet on odor and gas emissions from animal manure, already showing that reducing the amount of protein in animal diets reduces the potential emission of ammonia from manure.

Much of the feed animals consume is excreted. After excretion, microorganisms break down this undigested feed, along with the other partially digested material in the feces and urine. During the microbial degradation of manure, gases are given off. Research has identified at least 168 gaseous compounds resulting from the anaerobic decomposition of manure; of these compounds, 30 are responsible for the majority of manure odors (O'Neill and Phillips 1992). These odorous compounds can be placed into the general groups of carboxylic acids, alcohols, phenolics, aldehydes, mitroheterocycles, mercaptans, amines, and sulfides (Zhu et al. 1997). Many of these compounds contain nitrogen or sulfur. Much of the research on reducing odor through diet focuses on reducing nitrogen and sulfur intake. Other odor reduction research focuses on improving the digestibility and/or balance of various feed ingredients. To date, most of the work on odor control through dietary formulations has focused on the swine industry.

Sutton et al. (1998) reduced many gasous compounds through dietary (1) changes in protein and synthetic amino acids and (2) reductions in copper sulfate and ferrous sulfide. With a low-sulfur starter diet, Shurson et al. (1998) produced from 2% to 40% reductions in swine odor concentrations.

Limited research has shown decreases in ammonia emissions with increases in cellulose and other nonstarch polysaccharide sources in swine diets. In one such study, adding coconut meal, soybean hulls, or dried sugar beet pulp reduced ammonia levels from 6.4% to 35.8% (Canh et al. 1998). This research did not evaluate odor emissions; however, this type of research does indicate that gas emissions can be altered by simple dietary changes.

Other less traditional research has shown that there is also the possibility of masking manure odor through dietary changes. For instance, researchers at Clemson University showed that adding garlic powder to chicken diets resulted in a less offensive smell inside the facility. Not enough research has been conducted in this area to determine the impact of such odor-masking technology.

Dietary changes to reduce odor emissions offer little economic benefit. Typically, diet formulations that reduce odor are more costly than a traditional diet. However, if state and local regulations require the use of some odor reduction strategy, implementing dietary changes may be one of the least costly methods of odor reduction.

Summary. Diet manipulation to minimize odors is becoming an accepted concept. Odor generation may be reduced by adjusting animal diets to minimize the overfeeding of nutrients that might contribute to odors. The primary challenge with developing dietary formulations for odor control is maintaining a balance between odor control and the animal's health and performance. Dietary changes may also impact the quality of meat, egg, or milk products. The research to monitor these unintended effects takes time and is costly. This concept is discussed at length in Lesson 10, Reducing the Nutrient Excretion and Odor of Pigs Through Nutritional Means.

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