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MINIMIZING ODOR FROM CONFINEMENT FACILITIES BY MANAGEMENT PRACTICE

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Introduction

In planning a livestock facility or the expansion of an existing facility, a producer should give consideration to minimizing the potential for odor generation from animal manures. The principles of odor generation and the potential impact of state and local law and regulations are discussed in another extension bulletin, "Generation and Legal Regulation of Odor from Animal Manures." The principles of odor formation and the potential means of control are relatively few and straightforward even though odors frequently seem mysterious and difficult to manage. For an odor to be detected downwind odorous compounds must be formed, released to atmosphere, and transported to receptor site (human nose). These three essential steps provide the basis for most odor control technologies. If any one of these steps is inhibited, the odor will be diminished.

Management Guidelines to Minimize Manure Odors

Building Site Selection

Every animal production facility will produce malodors. Initial site selection therefore is of paramount importance. It is difficult to establish exact perimeters beyond which odor complaints will not be a problem. Odors can travel in excess of one mile downwind under some weather conditions. A site which seems ideal for a confinement facility to the animal producer because of easy access for transportation, feed supply, water and zoning regulations, may be inappropriate because of existing or proposed nearby residences or residential development, commercial enterprises, recreational areas, and well traveled highways and roads.

Two techniques, isolation and dilution, will reduce public conflicts over odor problems. Dilution of odors before it reaches sensitive areas can be accomplished by separation. It is desirable to stay at least one mile from (neath): residential developments, commercial enterprises, recreational areas and incorporated areas and 1/4 - 1/2 mile from neighboring residences even if the neighbors are farmers and are used to the smell of animals and manure. It is most important to maintain this separation in the downwind direction [ha! prevails during warm weather, when odor production is maximum. Dilution of odor can be achieved further by the presence of trees or shrubbery around the proposed livestock production site which encourages air turbulence to mix odorants with large quantities of air.

The site terrain is also important. During weather inversions the air mass near the ground is colder than the air above it. During these periods odors hug the ground and follow land depressions such as gullies or hollows. If nearby residences are located at the mouth of these land features, the odor intensity may be very strong.

The visual isolation of a livestock facility by land terrain or stands of trees reduces the potential for odor complaints. The sight-smell correlation ("out of sight--out of mind") of people tends to increase the perception of odor intensity and odor quality.

Odor from open-lot feedfloors can be reduced by site selection. Any effort to maintain a state of aerobic decomposition on the surface will help reduce odors. Wet manure will generate odors during anaerobic decomposition. The selection of a site that will give the feedfloor a southern exposure will enhance manure drying by utilizing energy from the sun. Also, the proposed feeding floor or loafing areas should be sloped at least 2% so that there is rapid drainage of precipitation.

Feedfloors and Open Lots

Manure management systems should be designed and operated in a manner that allows for ease of maintaining a clean, dry feedfloor. Manure adhering to the warm body of an animal promotes accelerated bacterial growth and odor production when the manure is wet. Feedfloors that allow accumulations of wet manure because of poor drainage, an uneven floor, or leaking waterers, promote anaerobic decomposition with resulting odor production. Animals stirring wet manure by their movement increase the rate of release of odorants. For feeding floors that are well drained, dry aerobic manure will absorb precipitation quickly and begin to decompose anaerobically. Scrapping of manure from lot surfaces before a rainfall will reduce the generation of odors.

A major source of odor from open feedlots can come from accumulated runoff from the floor. Runoff liquids are high in organics that easily decompose. Solid separation structures and retention ponds should be pumped and cleaned as soon as possible to discourage anaerobic decomposition. If a feedlot does not have runoff control structures anaerobic decomposition of the organics in ponds or pools of stagnant runoff water will generate offensive odors.

Enclosed Confinement Facility

Manure that is left on a feed floor longer than three to five days will have more odor than if it is removed more often. The exhausted air from a confinement building will contain a level of odorants that depend on the degree that they are generated from manure on the facility feedfloor. Flush systems reduce the odors inside a building and consequently the amount of odors that are exhausted by ventilation from a facility.

Anaerobic Liquid Manure Systems

Odors from pens and buildings are minimized if the design and operation of liquid manure handling facilities result in clean animals and clean pens. However, odors will almost certainly be released during pit agitation and pumping which may be a nuisance to neighbors. The following recommendations will help minimize odor problems during pit cleaning.

Agitate, pump, and field-spread manure only when climatic and soil conditions favor dispersion and dilution of the odors released and rapid drying of the field spread manure. Favorable conditions include:

- 1) low relative humidity,
- 2) high wind velocity preferably with gusting,
- 3) clear, sunny weather.

- 4) a soil that is dry enough to disk or plow.

Relative humidities are usually lowest and wind velocities highest between 10 a.m. and 4 p.m. Humidity usually increases and wind velocity decreases after 4 p.m. The most severe conditions for odor transport and detection at distances from the odor source usually occur between 4 p.m. and 8 a.m. Therefore, as a general rule, anaerobic liquid manure should be field spread between 8 a.m. and 2 p.m. This allows about 2 hours between 2 p.m. and 4 p.m. for the liquid manure to soak into the soil and dry before the period most favorable for odor transport. Liquid manure should be spread on days when wind direction is away from the nearest dwelling, well traveled highways or other sensitive areas.

Odor from field spread manure can be further reduced by soil injection of the liquid manure and plowing or disking the soil during or soon after field spreading.

Odors from the solids left in the bottom of liquid manure pits after they have been unloaded are more intense if the solids in the pits are above liquid level. Concentration of some odorants in the air is reduced because water will absorb manure odorants. Thus, it is recommended that when a pit is pumped down that at least a foot of water be pumped into the bottom of the pit. Afterbirths cause an intense odor source from liquid manure pits in farrowing houses. Remove the afterbirths from the building as soon as possible.

Managing manure pits so that they do not overflow and repairing manure pits that leak will reduce odor from confinement facilities. These liquids that stand or pond outside the facility and do not dry out will cause intense odors.

Physical control of odorant gas release provides a potential for odor control. Covers on manure storage tanks and anaerobic manure treatment devices are effective in controlling the escape of odorants. By reducing air exchange over manure slurries, the escape of odorous gases is reduced. Dairy manure generally forms a surface crust composed of fibrous matter (undigested parts of hay and silage) that reduces odor escape in uncovered storage pits. A crust can be formed if chopped straw is blown onto the storage surface. To prevent breaking-up of the crust during the storage period, injection of manure under the crust by use of a piston pump, sump pump, or chopper pump from a sump pit is recommended. Storage facilities loaded during the fall or winter will take longer to form a crust than those started in the spring and summer.

Odor reduction from pits can be reduced by several other methods. Chlorination of liquid anaerobic manure acts to kill bacteria that anaerobically decompose manure. If the pH is below 6.5, the addition of hydrated lime ($\text{Ca}(\text{OH})_2$) or lye (NaOH) at a rate of one pound per 1000 ft³ per day should be added until the pH is 6.7 or above. A three-fold reduction of hydrogen sulfide release can be achieved if pH is raised from 6.5 to 7.5. A ten-fold reduction is found if pH is raised to 8.0. Though hydrogen sulfide release is reduced, ammonia release which itself can cause odor problems is increased dramatically. Finally, aeration of anaerobic manures by using air distribution devices results in conversion of some odorants to compounds that are not odorous.

Anaerobic Lagoons

Anaerobic lagoons are generally the only type of lagoon systems found on farms for use in treating and storing animal manure. They are generally used with flushing systems in confinement animal facilities. Flushing manure from the building reduces

odors coming from the feedfloors. Anaerobic lagoons also are used to receive and treat raw wastes from overflowing pits and deep narrow gutters as well as waste effluents from oxidation ditches. A properly sized and managed anaerobic lagoon will not be a major source of bad odors on a year-round basis. The water color of a well functioning lagoon is reddish due to purple sulfur bacteria which eliminate odorous sulfur compounds. With every lagoon, there will be periods when odors become objectionable. Anaerobic lagoon odors are most common in the Spring when water temperature warms. Manure accumulated during the Winter (when little or no manure decomposition takes place) undergoes rapid decomposition. Significant odors will usually be released over a period of several weeks. To reduce this possibility, it is helpful to remove the liquids and refill the lagoon to the normal operating level with clean water before the lagoon temperature rises. Another occasion of odor release can occur in the Fall. As the surface water of the lagoon becomes cold, the water becomes more dense and sinks forcing warmer (and less dense) water to surface. The process is called lagoon overturn. The bottom water contains more odorous compounds than the surface waters. The time length of odor release and level of odor in the Fall is less than that experienced during the Spring.

Lagoons can cause odor problems if they are not managed properly. Overloaded or shock-loaded lagoons are more likely to have objectionable odors. Overloading of lagoons occurs when they are loaded with manure from more animals than the lagoon was originally designed to handle (see Soil Conservation Service and Cooperative Extension Service recommendations). Shock-loaded lagoons occur when large amounts of manure are placed into the lagoon at one time. It is recommended that manure be added to a lagoon at least once a week with once a day addition being preferable. Where multi-cell lagoons are used, it is important that the cell that is receiving fresh manure not be loaded in excess of design loading.

Keep the addition of arsenic, copper, antibiotics and other toxic feed additives to lagoon and storage pits at a minimum since they may retard bacterial breakdown of manure. When normal bacterial action resumes, objectionable odors will occur as they do in the Spring.

Site selection becomes doubly important since there is no practical way to prevent odor release from anaerobic lagoons. While some caution must still be exercised during emptying operations lagoon effluents are usually not as odorous as liquid manure from storage pits, and odors from spreading are not often a problem. But following similar recommendations, as outlined under The Anaerobic Liquid Manure Systems section, should minimize complaints.

If the pH of the lagoon is less than 6.5, hydrated lime $\text{Ca}(\text{OH})_2$ or lye (NaOH) can be added at a rate of one pound per 1000 13 daily to raise the pH of the lagoon to 6.7 or above. As noted previously increased pH reduces hydrogen sulfide release but increases ammonia release. Dilution of a lagoon by the addition of water can reduce odor generation.

Aerobic System--Lagoons, Oxidation Ditches

Naturally-aerated lagoons or oxidation ponds or ditches, if operating properly, normally will not cause an odor problem. However, when malfunctions or other circumstances cause aerobic systems to become anaerobic, odors will be released. These possibilities should be considered to minimize the chances of odor complaints. So-called

aerobic lagoons usually become anaerobic for a short period in the Spring because of the high oxygen demand for the buildup of organic matter in the lagoons over winter. Odors may be a problem during this period, which should be considered in site selection. Indeed, aerobic conditions are difficult to maintain in non-aerated farm lagoons because they are generally overloaded with manure.

Mechanically-aerated lagoons (surface aerators or submerged spargers) and oxidation ditches should not cause an odor problem as long as aeration equipment is adequately sized and is functioning properly. Equipment breakdowns, power outages, or improper loading, however, may result in anaerobic conditions and odor production. Restarting aeration equipment following a malfunction may aggravate the problem by hastening release of the anaerobic decomposition gases from the manure. Occasional failures are almost impossible to prevent, but they are factors to consider during planning of livestock facilities.

Before a decision is made on using a mechanically aerated lagoon or ditch, the energy costs should be evaluated. With rising electrical costs the facility may prove to be costly in the long run and an alternative waste storage facility may be more economical.

Commercial Odor Chemicals

A review of the use of odor control chemicals can be found in the extension bulletin, "Feasibility of Manure Odor Control Using Commercial Products."

Further Information

Additional information can be obtained from your County Cooperative Extension Service and Department of Agricultural Engineering at the University of Kentucky, Lexington, Kentucky 40546.

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