# ODOR CONTROL FROM LIVESTOCK WASTE HANDLING SYSTEMS

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February 24, 1993

Odors originating from livestock wastes are often the source of irritation between agricultural producers and rural and suburban neighbors. Because individual tolerance for farm related odors varies substantially and odor is so difficult to quantify, it is likely to remain a unregulated environmental issue. However, odor is often the problem that draws attention to a farm and can expose other environmental problems more easily quantified and regulated. In addition, odor contributes to an agricultural producer's challenge of maintaining acceptable neighborhood relations.

The nuisance caused by odor is a function of individual perception. An individual's tolerance is often based on one's understanding of the farms in the neighborhood and the families who manage those farms. Communications between farm and non-farm families impacts the perceptions of many people as to the severity of the odor problem. Some of the most effective odor control programs implemented by livestock managers have emphasized maintaining good neighborhood relations and communications. Although the following information focuses on technology and management based alternatives, the importance of community relations should not be overlooked.

## THE PROBLEM SOURCE

The decomposition of manure produces more than 75 odorous compounds. The most common gases produced are described in table 1. The two most annoying gases are hydrogen sulfide and ammonia. Odors are most often a result of anaerobic decomposition (biological processes occurring in the absence of oxygen) of livestock waste. In an anaerobic environment, the presence of sulfate in liquid manure will lead to hydrogen sulfide production by a group of sulfate reducing bacteria. Hydrogen sulfide is heavier than air and is slow to disperse. Sulfur related odors tend to be dairy manure's most annoying odors and as a result avoidance of anaerobic conditions is desirable. Ammonia is produced by both anaerobic and aerobic processes (biological process occurring in the presence of oxygen). Ammonia is commonly observed in housing facilities. However, it is lighter than air and disperses more quickly outdoors.

Table 1. Common gases from decomposition of livestock wastes (from presentation by W.C. Ghiorse, professor of microbiology, Cornell University).

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| Carbon Dioxide | Nontoxic, odorless, high concentration limits oxygen supply. |
| Methane | Nontoxic, odorless, lighter than air, explosive |
| Ammonia | Mildly toxic, pungent odor, lighter than air, irritates eyes, nose and throat. |

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| Hydrogen Sulfide | Toxic, causes respiratory paralysis, unconsciousness, and death. Rotten egg odor and heavier than air. |

Several physical conditions to which manure is exposed impact the level of odor produced by manure. Those contributing factors include:

1) Presence or absence of oxygen. Anaerobic conditions produce the most annoying odors and aerobic conditions minimize odors.
2) Temperature. Warmer temperatures speed biological processes and increase odors. Every 20°F increase in temperature doubles the speed of the biological reactions.
3) Manure moisture content. Liquid manure promotes anaerobic conditions and increased odor problems. Drier manure encourages aerobic conditions and lowers odor levels.
4) Time. If manure accumulates longer than 3 to 5 days, offensive odors are a greater nuisance. Little odor is produced during the first three days. Ammonia production peaks at 3 days and again at 21 days. Anaerobic activity is a slower biological process producing odors over extended period of time (several weeks to months).
5) pH. Manure usually has a pH of 6.6 to 7. Both aerobic and anaerobic biological processes prefer these conditions. Dropping manures pH to 5.0 reduces ammonia emissions. Raising pH above 12 for at least 30 minutes destroys odor producing microorganisms. A pH of 8 or more begins to slow anaerobic activity and reduces release of hydrogen sulfide.
6) Concentration of manure. Since the level of nuisance is directly dependent upon concentration of odor, the level of nuisance is also directly dependent on the concentration of manure at a single location.

The previous factors are directly involved in several farm systems and practices that have added to agriculture's odor problems. Some of these systems and practices include:

1) Liquid manure storage and handling. Liquid systems encourage anaerobic conditions and the production of hydrogen sulfide. Solid manure systems that include considerable bedding and avoid additions of water such as milking center wastes tend to be less offensive.
2) Agitation and surface application of manure on land. Stored manure tends to trap odors in solution. Agitation and surface application of livestock waste on land encourages rapid volatilization of odorous compounds.
3) Irrigation of stored liquid wastes. Sprinkler irrigation is noted for rapid release through volatilization of odorous compounds and production of aerosol sprays which carry odors for considerable distances.
4) Animal housing or exercise lots that are not scrapped every few days. Warm, wet conditions add to this problem.

## POSSIBLE SOLUTIONS: SITE SELECTION

Minimizing odor begins with site selection for manure storage, animal housing, and irrigation systems. Isolation of odor producing facilities and equipment from neighbors reduces the potential for odor nuisance. A

minimum distance of 1000 to 2500 feet is commonly recommended. However, one must temper any rule of thumb with knowledge of prevailing wind direction (especially during warmer months), location of neighbors, and air drainage considerations. Neighboring residences that are down-slope from a livestock facility, especially those in a valley, provide a unique challenge due to air drainage. During calm summer evenings, cooled air near the ground moves down-slope and is trapped in a valley. Odors from a livestock facility travel with this air and are concentrated in the valley during summer evening hours when people are normally outdoors. Distance, neighbor location, wind direction, and air drainage should all be considered during site selection.

As waste storage facilities are added to existing livestock farms, location should be a consideration. In addition to the above mentioned factors, waste storage location next to the livestock housing or at a remote site deserves consideration. Remote waste facilities at the site of fields on which manure will be spread can reduce peak labor requirements at the time of spreading and may produce odors observed by fewer people.

## POSSIBLE SOLUTIONS: EXISTING FACILITIES

Many odors originate from the housing facilities and associated eating and exercise areas. Controlling odors from these facilities begins with good house keeping. Facilities that allow efficient collection of manure daily and minimize mixing of rain water with manure promote fewer facility related odors. Cleaning up manure spills and other house keeping practices produces beneficial results.

When working with an existing storage facility, the options for odor control are few and costly. Where practical, solid manure handling systems should be considered for minimizing odor problems and the quantity of manure to be hauled. When liquid systems are preferred, storage structure designs that encourage floating crust formation are recommended. Alternatives to agitation should also be considered, including a means of removing floating crusts and settled solids without agitation. Does the entire storage contents need to be handled as a liquid? Does the entire storage contest need to be removed? A concrete ramp and storage bottom for earthen storages allows solids removal without agitation. Artificial scum materials have been applied to swine waste storages with some degree of success. Scums from rice hulls or grass clippings with waste oil have effectively reduced odors by filtering odors and physically confining odors.

Treatment of manure to reduce odor can be an effective but expensive alternative. Anaerobic digestion systems which capture the gases produced during anaerobic activity provide an effective means of controlling odors both during and after treatment. In addition, energy can be recovered from these systems (between 2 and 2.5 kWh per cow per day) and more homogeneous, liquid manure is produced. A combination of these benefits can make this an attractive option especially for larger dairies (250 cows or more) and farms anticipating irrigation of manure. All larger farms should design their waste handling facilities with space available for this option in the future.

Anaerobic and aerobic lagoons provide two additional options. Aerobic treatment requires the additions of large quantities of oxygen, usually

by mechanical means, to supply the oxygen needs of aerobic processes. To provide the oxygen needs of strictly the carbon related compounds would require between 2600 and 2700 kWh of electricity per cow per year ($260 to $270 per cow per year for electricity at 10¢ per kWh). The capital and energy costs of this approach have generally discouraged this approach. Anaerobic lagoons have generally been restricted to warmer climates and dilute waste streams. Their application beyond milking center waste treatment is relatively unproven in New York. Anaerobic lagoons can also be a source of odor especially in the spring as biological activity increases due to warmer temperatures.

A variety of chemical treatments have been suggested over the years with limited effectiveness. pH adjustment shows the most promise. The addition of acid to manure to reduce manure pH to 5 causes increased nitrogen fixation and reduced ammonia related odors. Ammonia emissions reductions of up to 60 times have been reported. Lime additions to septage to increase pH to 12 for at least 30 minutes is an accepted practiced for destroying odor producing microorganisms and minimizing odor. Significant reductions in hydrogen sulfide production have been reported when swine manure is raised to a pH of 9.5.

A variety of other approaches have been introduced for chemical treatment of odors. "Masking agents" (perfumes) attempt to cover up the wastes odor. "Counteractants" are designed to neutralize or cancel the odor of the waste. "Digestive deodorants" include bacteria or enzymes that encourage biological processes that produce less odor. "Absorbents" are products with large surface area that absorb the odorous compounds. "Feed additives" attempt to reduce odor by enhancing animal digestive processes. "Chemical deodorants" either attempt to disinfect waste products by eliminating bacterial actions or oxidize odorous compounds into less offensive ones by chemical oxidation. Ozone, hydrogen peroxide, and potassium permanganate have been used as oxidizing agents in the literature. In general, the quantity and frequent application requirements of these chemical treatments have made these approaches an expensive alternative to good design and management and should be considered in emergency situations only. Individuals interested in use of chemical agents should be cautious and consider their use on a trial basis before making any significant investment.

## POSSIBLE SOLUTIONS: LAND APPLICATION

Careful evaluation of manure application timing and location generally provides the most appropriate immediate response to dealing with an odor issue. Key considerations in surface application of manure include:

1) Cold weather applications produce fewer odors than warm weather applications. This must be balanced against runoff issues.
2) Early morning applications are preferred during warm weather. Rising air temperatures causes air to rise and carry odors away. Drying of the manure during the day also reduces odors before evening activities by neighbors.
3) Dry, windy days produce fewer odor complaints than calm humid days.
4) Immediate soil incorporation or injection dramatically diminishes odors. If soil conditions allow for incorporation, this alternative allows the greatest flexibility in field application while minimizing odor concerns.

Irrigation applications of manure provide one of the greatest challenges for odor control. The odorous compounds produced during storage are released during irrigation. High pressure spray of wastes atomizes the liquid (and odorous compounds) into aerosols that can travel great distances. The above recommendations will reduce the problem but may not be sufficient to eliminate irrigation related complaints. Site selection for irrigation systems should be carefully evaluated for potential odor related risks. Once irrigation is selected as the method for spreading manure and a site is selected, the options for controlling odor become limited. Farms with serious odor problems resulting from an irrigation system should consider treatment options such as anaerobic digestion.

Control of odors from livestock wastes is an issue for which the benefits are not always immediately obvious or measured in financial terms. However, where non-farm and farm populations come in close proximity, the benefits of odor control cannot be overlooked. Addressing this issue begins with a strong effort upon the farm manager's part to promote good community relations and communications. In addition, options for facility's site selection, management of manure storages, and field application play an integral role in controlling odors. If these options do not sufficiently address the issue, additional, relatively expensive options exist for treating waste and minimizing odor nuisances.

Suggested References:

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ps. What is the difference between "humor" and "odor"?

Humor is a shift of wit....Odor is a wiff of sh...