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Generation and Legal Regulation of Odors form Animal Manures

J. L. Taraba
University of Kentucky

R. M. Williams
University of Kentucky

UNIVERSITY OF KENTUCKY
COLLEGE OF AGRICULTURE
Lexington, Kentucky 40546

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Generation and Legal Regulation of Odors form Animal Manures

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The present trend of animal and dairy product producers is toward total confinement facilities and larger animal herds. Generally the rewards to the producer for these practices are higher economic returns which result from higher feeding efficiencies and better quality products. However, total confinement is not without problems that were previously not present or were minimal in nature when animals were maintained in fields. Confinement facilities have a greater impact on environmental quality of both water and air. Presently, one of the major problems facing animal and dairy product producers is odor production. The greatest number of complaints concerning environmental pollution from these facilities arise from odor complaints made by nearby neighbors, communities and passerby to the producers, the local health department, the state and federal environmental protection agencies, and the local prosecutors. Odor complaints may even come from the producers own family, farm workers or contract construction workers.

ODOR REGULATION: STATE LAW AND ADMINISTRATIVE REGULATIONS

The conflict between livestock producers and the public often arises because of increased movement of urban families into rural areas and increased public concern toward the quality of life and the environment. This conflict is now being reflected in rules and regulations designed to protect the public from malodors generated by livestock production facilities. These rules and regulations are being applied as additional restriction on the location, design, and operation of animal production enterprises.

Presently there are legal tools available to abate or decrease odor production if it is proven that the odor is a public nuisance or consistently exceeds regulatory limits. In law a nuisance is an offensive, annoying, unpleasant or obnoxious thing or practice which usually is

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a continuing or repeated invasion or disturbance of another person's rights. The Kentucky Department of Human Resources has the authority to abate all nuisances within the State (KRS211.210). Further, county and city health boards also have the power to abate nuisance (KRS212.245). An individual, through an attorney, can initiate a private nuisance suit when that individual concludes that the existence of a nuisance, due to the activities occurring on the property of another individual, impairs his right of reasonable comfort and convenience in the use of his own property. The suit can seek to correct or eliminate the nuisance or also to collect damages: it is brought before the Kentucky Circuit Courts.

The Division of Air Pollution Control in the Kentucky Department of Natural Resources and Environmental Protection implement the Kentucky air pollution control program (KRS224.005). Air contaminants are defined to include odors. The odor regulation requires that odor not be detectable at equal to or greater than 7 dilutions on a Barnebey-Cheney scentometer (see Odor Measurement section) at the property line of the farm from which the odor is generated (401 KAR 53:005).

The ultimate threat to the animal producer is forced shutdown of his facilities or operations and the resulting economic loss. The animal producer must be aware of some of the basic facts concerning odor production and control. He should be prepared to practice those techniques appropriate to his location for reducing odors to operate compatibly within the community and to provide maximum self protection.

Odor Generation From Livestock Facilities

Odor intensities depend upon several factors which if properly managed could result in minimizing odors from confined animal production operations. Two physical variables that affect the generation of malodors from manure are temperature and moisture content.

The decomposition of organic matter in animal manure by microorganisms causes the production of odorous gases. Microorganisms produce these odorous gases as a natural part of their growth and metabolism. As a general rule, the rate of organic matter decomposition resulting from microbial growth and the malodors produced doubles for each 18°F rise in temperature in the range of 50 to 100°F. Bacterial decomposition virtually creases around the freezing point of water but is extremely active in warm weather. Hence, odor intensities are maximum in warm weather if moisture conditions are not limiting.

Experiments with poultry manure have shown that manure odor intensities are proportional to moisture content (approximately), with high moisture contents yielding the greatest odors. This is readily evidenced by the facts that feedlot odors are maximum soon after a rainfall and handling manure as a liquid or slurry produces greater odors than solid waste handling procedures.

The effect of moisture content can be explained as follows. For moisture contents greater than 65%, manure is effectively water saturated and thus poorly aerated so that anaerobic bacteria, which live in an environment devoid of free oxygen, decompose the manure organic matter. The end products of anaerobic decomposition include carbon dioxide, water, heat and methane (a potentially recyclable gas) plus a variety of odorous gases that can be divided into two principle classes of compounds: those that contain sulfur, e.g. hydrogen sulfide, mercaptans and sulfides and those that contain nitrogen in the amine form e.g. ammonia and amines. Paradoxically, many of these odorous compounds which have concentrations that are measured in parts per million or billion, account for considerably less than 1% of the gases and volatile compounds emitted in anaerobic decomposition. The generation of these compounds is affected by the type of livestock and is primarily associated with the level of protein and amount of roughage in the feed ration. For example, poultry and hog wastes produce more offensive odors than cattle wastes.

By contrast, if the manure moisture content is below 50% free oxygen will generally be present in the manure so that aerobic bacteria, which must have free oxygen available for their growth, will decompose the manure organic matter. The end products of aerobic decomposition do not include the aforementioned odorous compounds. Therefore, dry, well-aerated manure on feedlot surfaces or beneath poultry cages has little odor.

Finely divided manure dust particles at extremely low moisture content (i.e., below 10%) will stimulate the smelling senses in the nasal cavity, creating a strong odor sensation, even though bacterial decomposition is essentially inhibited.

Odors from manure decomposition on feedlot an in manure storage facilities are not the only potential odor source. Decomposed feed materials also contribute to odors. Some food processing wastes fed to livestock are particularly notorious in this respect. Ensiled cannery wastes, wet whey, cooked garbage and other biologically decomposable materials deserve particular attention. Solving these odor problems must be weighed against the benefit of using a waste material that is being put to its greatest potential use as a valuable feed ingredient. Another odor source from animal production facilities are dead animals that are not quickly buried or removed from the site. In fact, any organic compound which can support the growth and reproduction of microorganisms can become a potential source for the production of malodors.

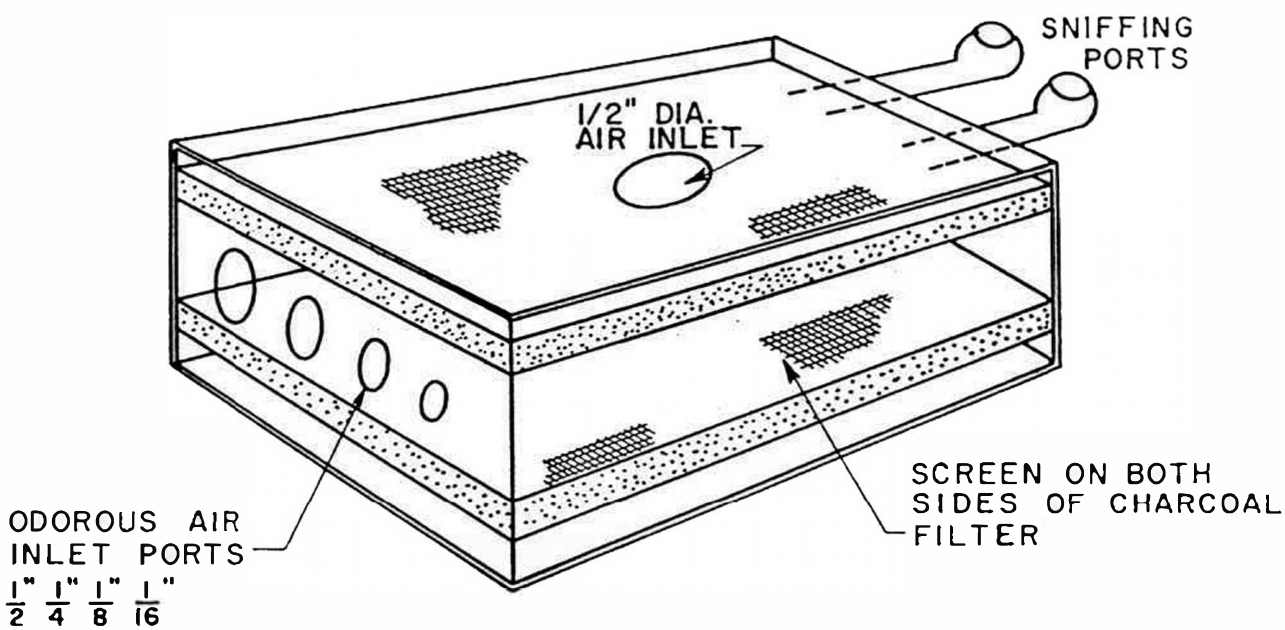

DIAGRAM OF SCENTOMETER

Odor Measurement

The evaluation of odors is a personal response based upon the sensitivity of the person involved, his previous experience, and momentary disposition. Research has identified more than forty organic compounds in the air near manure storage or treatment facilities. Many of these compounds are known to be malodorous in trace concentrations. Most quantitive measurements of odorant concentration suggest, however, that the odor perceived from livestock production enterprises is a result of the mixture of odorous compounds, since all or perhaps most of the individual compounds ar present in concentrations below the threshold at which they can be detected by humans.

The major obstacle to developing effective odor control techniques, writing guidelines for odor control from animal production facilities, and litigation of odor cases is the lack of suitable quantitative methods for measuring the intensity and quality of odors. The first research attempts sought to develop precise relationships between chemical composition of odorous compounds (odorants) and the odor scent ("quality") experienced. The gas chromatograph became the most important instrument for supplementing the human nose in identifying and quantifying the odorous substances present. Unfortunately, some odorous compounds cannot be detected at very low concentrations (parts per billion range) with the gas chromatograph even though they are readily detectable by the human nose. Attempts to classify or evaluate odor quality according to concentrations of odorous compounds can only be detected by the human nose when accompanied by other odorous compounds. Thus the human nose is still the best available sensing device for detecting odors in most situations.

A usable odor measurement is odor intensity which is often measured by a Barneby-Cheney Scentometer (see figure). This device consists of a plexiglass box that is held in front of the nostrils in such a way that only air which has passed through an activated carbon filter is breathed. By standing on the site to be evaluated and breathing through this device, it is possible to keep odorous compounds from entering the nostrils. Be selectively opening unfiltered air ports, one can determine the ratio of odor-free air required to dilute a volume of odorous air to the barely detectable concentration. By use of this technique, it is possible to estimate quantitatively the odor intensity. Since quantitative measures are helpful in discussing and describing odor problems and in documenting improvement in odor control, this had proved useful.

Measurement of odor quality is much more difficult since there is no accepted standard. Odor quality testing is usually performed by characterizing odorants using non-standard descriptive terms (such as "burnt," "spicy," "ethereal," "aromatic," etc.) representing basic odor classes. This type of testing is based heavily on human judgement.

Odor testing methods available to field situations such as confined animal feeding operations are inherently subjective and depend upon human limitations, such as the following:

a. Adaptation - The intensity of odor sensations diminisher with time.

b. Fatigue - Complete exhaustion of sensitivity to an odor may occur after two or three minutes exposure time.

c. Anosmia ("odor blindness") - Many persons are either partially or totally insensitive to odors.

d. Parosmia - Some persons experience temporary loss of their ability to distinguish odor quality.

e. Age - Sensitivity to odor intensity is usually maximum between 20 and 50 years of age. Also, tolerances and preferences to odor qualities change with time.

f. Personal Habits - Smoking and consumption of drugs, even caffeine, alters human perception of odors.

g. Odor Concentration - The human nose cannot distinguish between odorant concentrations differing by less than 50%. Also dilution of an odorant sometimes changes its quality.

h. Odorant Mixtures - Admixing of two or more odorant compounds may either increase or decrease resultant odor levels.

i. Temperature - Human perception of odor intensity may vary with temperature being highest near 100°F.

j. Uncertainty - Untrained odor observers tend to be indecisive or forgetful when comparing odor intensities.

For Further Information

Additional information is provided from two bulletins: Minimizing Odor from Confinement Facilities by Management Practice; and Feasibility of Manure Odor Control Using Commercial Products. These bulletins can be obtained from your County Cooperative Extension Service and the Department of Agricultural Engineering at the University of Kentucky, Lexington, KY 40546-0276.

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