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CANADA PLAN SERVICE

ODOUR CONTROL FOR LIVESTOCK FACILITIES

B. West'

BACKGROUND

The trend towards larger livestock operations on smaller land holdings, combined with rural urbanization, increased recreational uses of land, and increased public environmental sensitivity has greatly increased the incidence of odour complaints. Many livestock operations store large quantities of manure for utilization by crops. To avoid conflicts with neighbours, the livestock industry is faced with new challenges in economic manure management.

Livestock production produces odours primarily as a result of anaerobic decomposition of manure. This microbiological process occurs in the absence of dissolved oxygen in stored manure. Over one hundred different odour compounds have been identified as a result of this naturally occurring process.

Odour is a subjective response by people to an airborne compound or particulate. Some substances are considered pleasant or inoffensive, but some may be extremely offensive. A substance's nuisance level may depend upon its intensity and concentration as well as the subjective response by the person experiencing the odour. *Adaption* to an odour can occur and is the adjustment of the observer to the odour with the odour response diminishing with time even though the stimulus is applied at a steady rate. Livestock operators themselves have little ability to make unbiased odour judgments because of their constant exposure to the odours in the livestock environment around them. *Fatigue* or complete exhaustion to the sensitivity of an odour may occur at very high levels of odour intensity. This is particularly relevant when toxic gases such as hydrogen sulphide (H2S) are involved.

Concentration may significantly change the odour quality. *Mixtures of odours* have been studied and it has been found that the odour level of the combinations was between the sum and the average of the individual odours.

Other factors affecting an individual's response to odour are *age, sex,* and *habits* such as smoking. Perhaps the greatest factors of all influencing a persons perception of odour as normal or offensive are their *background* and *experience.*

Odours from livestock facilities are well below occupational health minimums. They are not considered to be hazardous to human health but rather nuisance pollutants. Distress associated with the nuisance may cause real or perceived illness.

Odour nuisance is a site specific problem. Therefore, it is usually dealt with by local legislation rather than federal or provincial statutes. It may be regulated under health, environmental, agricultural or land use legislation, or a combination of jurisdictions. In agricultural areas it is understandable that detectable nuisance odours will occur. Since odour nuisance is the unreasonable interference of the enjoyment of one's property, the question becomes one of what is unreasonable.

Nuisance is a function of odour frequency, intensity, duration, and offensiveness. This has been referred to as the FIDO relationship.

MEASUREMENT OF ODOURS

A means of accurately assessing odour intensity and quality has not been successfully developed. Measurement is complicated since the subjective perception of a nuisance odour is not only dependant upon the intensity but also the frequency and duration to which the receptor is subjected to

' Saskatchewan Department of Agriculture, Saskatoon,

COMPLETE INSTRUCTIONS

The Canada Plan Service, a Canadian federal/provincial organization, promotes the transfer of technology through factsheets, design aids and construction drawings that show how to plan and build modern farm structures and equipment for Canadian agriculture.

For more information, contact your local provincial agricultural engineer or extension advisor.

the odour. Two approaches have been taken; organoleptic (sensory) and *physical/chemical.* Odour measurement can focus on its quality (offensiveness, intensity) or on the measurement of specific odour compounds as in physical/chemical analysis (ppm, %). Each approach presents special problems.

ORGANOLEPTIC MEASUREMENT

• Threshold Determination Level (TDL method)

A sample of odorous air is diluted with clean air until the odour can no longer be detected. The number of volumes of air required to dilute the odorous air to the threshold level is called the threshold odour number or odour units per unit volume.

Experience by some researchers recommends beginning with non-odorous air and gradually adding odorous air until the threshold level is reached. This avoids the desensitizing of the olfactory sense that occurs when starting with odorous air and then adding non-odorous air until the threshold point is reached. The device for determining the TDL is called an olfactometer.

• Pyridine Equivalent

Odour measurements are made by a panel in an odour laboratory by comparing emission air to a comparison gas (pyridine).

• Fabric Swatch

Cotton fabric swatches are suspended in odorous air for a specified time. Then they are tested for odour quantity and quality.

PHYSICAL AND CHEMICAL MEASUREMENT

• Gas Chromatography

Provides the most dependable procedures for identifying odorous manure compounds. A range of detection technologies - thermal conductivity, flame ionization, electron capture, flame photometric, and electrolytic conductivity - improves the selectivity of this technique. While a very useful measurement technique, the gas chromatograph cannot measure the quality of the odour. Often sensory- measurements are combined with gas measure the quality of the odour. Often sensory measurements are combined with gas chromatography evaluation.

• Gas Detectors

Detects levels of individual gases such as ammonia (NH,), hydrogen sulphide (H2S), carbon dioxide (C02), methane (CH), and carbon monoxide (CO). Knowing the levels of these gases is useful from a safety standpoint since high levels of H2S and CO are lethally toxic. C02 is an asphyxiant and CH, is explosive. A high NH, level is suspected to adversly affect livestock health and production.

Such measurements are not useful for odour determinations since odour threshold levels are much below the measurable range of most gas detectors. Consult CPS leaflet "Manure Gas" for additional information on this topic.

Research is required to determine which compounds can be correlated with odour quality. Several compounds which are suspected as contributing to odour are NH, p-cresol, skatole, and various volatile organic acids.

SOURCES OF ODOURS

The strategy for odour control requires an understanding of odour sources and causes. Most objectionable livestock odours result from the gases produced when manure decomposes under anaerobic conditions. Any handling and/or treatment which inhibits this biological anaerobic action will be effective in decreasing the production of some of these gases.

- Animal Odours
  Animals and their fresh feces have characteristic odours. Unsanitary housing conditions where animals are dirty may increase odour. Body heat and moisture promote bacterial growth and odour production. Odour is also a function of animal type, feed, and housing system.
- Open Lots
  Feedlots, paved or unpaved, consist of large surface areas of exposed manure which are subject to odour production. Odour emission depends on amounts of manure accumulated and the moisture content. Weather conditions have a great impact on surface conditions and odour production. In arid and windy regions, dust may contribute to the nuisance problem.
- Anaerobic Storages
  Manure allowed to undergo anaerobic decomposition will produce malodours. Open storages are particularly significant in this regard. Under pit storage and collection pits may contribute to high yard odours. Any action which disturbs the storage volume, such as top filling a lagoon, or wind disturbance, will result in odour release.
  NOTE: Disturbance of manure storages produces large quantities of gases which can be hazardous to the safety of humans and livestock.
- Ventilation Air
  Exhaust air from livestock buildings is a lesser source of odour, dust, and feathers. Increased attention to in-barn sanitation and air quality reduces odours in the discharged air.

• Land Spreading of Manure

The single event having the greatest odour impact is the spreading of anaerobically stored manure on land. Disturbance of the manure in storage plus spreading it on the land allows the escape of many volatile odorous compounds.

• Dead Animals

Dead animals not properly disposed of can be a source of odours, flies, and disease.

• Feed Materials

Fermenting waste feed can produce odours. Silage and food processing wastes fed to livestock are particularly offensive in this respect.

In addition to an odour source, there must be a transport mechanism to carry it to the receptor. Site specific factors such as prevailing winds, separation distance, and topography are involved.

MANAGING ODOURS

Odour control focuses on manure management options as well as location with respect to neighbours. Siting has been a popular means of reducing odour nuisance for new operations. Optional sites may be available whereas management alternatives may be available only at great cost. The siting aspect of livestock facilities has limitations in managing odours since it is based on the assumption that livestock facilities produce odour. Separation doesn't deal with the odour source but rather with dilution as a means of lowering odour frequency, duration and intensity to *acceptable* levels. This approach may not achieve success in all cases.

Technical approaches for odour control attempt to prevent the formation of odour at the source to prevent odours from being released to the environment and to eliminate the means of transporting these odours to the neighbours. Economically viable options for manure treatment for odour control are, however, few. Some odour control possibilities are:

SITING Separation distance is often the most practical way of avoiding odour complaints. Separation allows the dilution of odours to reasonable levels before they reach sensitive neighbours. Individual provinces may have legislation and/or guidelines regarding the separation of livestock facilities and neighbours. The existence of such programs should be investigated prior to committing to a site.

Choice of suitable topography can also minimize nuisance. Sites that will be subject to the movement of odours towards neighbors, should be avoided. Topography that encourages the mixing of odours by the passing air will reduce the intensity of odour.

SYSTEM CHOICE

- Solid manure.

  Dry manure management systems are less odorous. Drying of manure and/or the use of bedding materials can help in this regard since anaerobic decomposition is much reduced at low moisture content. The biological activity that creates odour is greatly reduced at moisture contents below 25%. Unfortunately drying systems are not common due to cost.

  Economically, solid manure lends itself well to composting provided the final product has a market.
- Liquid manure.

  Ease of mechanizing has resulted in most hog and dairy operations using liquid manure systems. These operations are the most subject to odour nuisance.

COVERED STORAGE Covers reduce odours significantly. In high rainfall areas, covers serve a dual purpose by keeping rainfall out of the storage. In low rainfall areas, covers of light weight films of various compositions (soft covers) are of interest. Work is being done in several parts of Canada to develop effective and inexpensive covers. High winds may limit the use of these materials.

Other materials being investigated as covers are various organic materials such as peat moss, wood shavings and straw which can act as floating organic lids. Some of these materials have high absorptive capacities to filter out odours being produced.

Results from tests in Saskatchewan in 1995 have shown that peat moss and wood shavings sank too quickly after application to be practical as a cover material. The peat moss and wood shavings also created problems during pump out. However, good quality barley straw applied to the lagoon surface with a straw blower to a depth of six inches (150 mm) provided effective odor control for an extended period of time.

STORAGE MANAGEMENT Odour is in proportion to the volume, the surface area, and the temperature of the stored manure. A 5°C increase in temperature can double bacteria activity. Emptying the storage in late spring reduces odour production during the hot summer months. Minimize the surface area to volume ratio.

Anything that disturbs the storage such as a top discharge and exposure to the wind, should be avoided. Manure storages should be screened from view to minimize visual impact.

SANITATION A high level of sanitation will reduce odour from the feed processing area, feed bunks, silage pits, and manure storage areas. Aesthetics should provide an attractive appearance to the livestock operation so that neighbors and visitors perceive the facilities to be clean and well managed. Visual screening should be considered to block public view of manure storage and any other parts of the livestock operation that may trigger nuisance complaints. Out of sight and out of mind can likely be applied to livestock operations.

AERATION Mechanically adding air to stored manure at an adequate level reduces the production of the odorous gases. Aeration is a well proven method of odour control for municipal and industrial wastes. Due to the high organic strength of livestock wastes, aeration of agricultural manure has not been cost effective to date. The following are treatment methods using aeration that show some promise and are worth considering:

Pre-storage Aeration

The high oxygen requirement for aerating animal manures plus prolonged winter conditions makes totally aerated storages impractical. An alternative is to treat manure at a high aeration rate for a period of five to ten days prior to storage. Dissolved oxygen levels must be maintained at over 2 ppm. A substantial amount of the more volatile solids in the manure are treated prior to entering the storage. Experience has demonstrated a significant reduction of odour especially when manure is land spread soon after treatment.

Pre-storage aeration fits well into a manure recycling, flushing gutter system due to the high quality flushing liquid produced. Solids separation is recommended prior to the treatment tank.

Liquid Composting

Liquid composting involves the mechanical aeration of stored liquid manure sufficient to maintain a temperature in the storage of about 30°C. This process is particularly useful in reducing odours when manure must be applied throughout the growing season on forages or other growing crops. Liquid composting improves the handling characteristics of liquid manure. Liquid compost can be spread with conventional irrigation systems. A properly designed system results in nitrogen losses no greater than most open storages. As an example, Norway has over 1 000 piggeries using this treatment method.

Sequencing Batch Reactors (SBR)

A further development of aeration technology is the SBR. The manure is treated in alternating on-off high aeration/settling cycles. Application of this treatment for odour control is limited by high cost. The SBR was designed to produce an effluent suitable for discharge to a water course rather than odour control.

ADDITIVES Many commercial products on the market claim to provide odour control and solids reduction of livestock manures. Such products are difficult to assess. Results are generally based on testimonials rather than research data. Full scale evaluation requires elaborate research facilities and resources. Support to evaluate manure additives has not been adequate in Canada. The limited research done to date has been inconclusive.

OLIGOLYSIS Some promising results have come out of investigations where an electrical current is passed through stored manure. The evidence from pilot scale testing seems to indicate that the process removes H_2S from the liquid manure and perhaps inhibits the formation of various other sulphur containing odour compounds.

This technique requires field testing to determine whether it is practical. At this date, optimal design parameters are not known.

LAND APPLICATION Many odour complaints result when manure is applied to land. How, when, and where manure is applied can greatly affect its nuisance impact near the spreading site.

Recommendations for land spreading are listed below.

- Incorporate Manure.
  Manure should be incorporated as soon as practical. Left on the surface, odours are released for extended periods of time. Nutrients lost to the atmosphere represent a significant economic loss.
- Frequency of Application.
  A major contributor to nuisance is the frequency of the nuisance event. Frequent application of manure to land adjacent to residences increases the potential for conflict. Long term storage allowing once or twice per year application to land is recommended.
- Communicate with Neighbors.
  Prior to spreading manure, contact neighbors regarding conflicts with any major social events. Do not spread on long weekends. If possible, avoid spreading on all weekends during the summer.
- Time of Day.
  Spread in the morning when the air is warming up and rising. This tends to dilute odours and reduce the nuisance level. Late afternoon spreading, when the air is cooling, keeps odours concentrated at the ground level. This increases the potential for conflict .

OPEN LOTS Frequent cleaning and a high level of sanitation is the most effective means of minimizing odours from accumulated manure in open lots.

Recommended management practices must consider the diversity of soils, climate, and topography.

• Drainage.

Provide good drainage by sloping the lot two to four percent. This enhances drying of the lot surface thereby reducing odour and dirty livestock. Drainage from the lot must be contained on the owner's property in a manner that will not result in groundwater contamination. Review local regulations to determine standards or requirements for containing run-off. Catch basins should be pumped out soon after run-off events so that effective run-off storage is restored. The catchment basin storage is dependant on the slope, the soil type, and the predicted snowmelt and/or precipitation data for the specific area.

As manure accumulates on the surface of the lot, drainage becomes less effective. Frequent removal of manure results in better drainage and less potential for intermittent odours from the lot surface. Similar to clean out of liquid manure storages, clean out of the lot can create high odours when the stored manure is disturbed. Deciding on the time and location of manure spreading should consider the effect these activities have on neighbours.

• Mounds

Well bedded earthen mounds provide livestock with a dry resting area. This results in cleaner cattle, better overall sanitation, and less odour originating from the lot area.

• Bedding

Odour is directly related to the amount of moisture in the manure. At moisture contents above fifty percent, anaerobic decomposition rapidly accelerates especially at warm temperatures. Bedding reduces the moisture content of the manure pack.

• Watering System Maintenance.

Prevent watering facilities from overflowing. This prevents the continuous wetting of manure and associated odours from forming in the area adjacent to the watering facility.

DEAD ANIMALS Check local regulations prior to establishing a dead animal disposal program. Pick-up by rendering plants, burning in an approved incinerator, composting and burial are common methods of dead animal disposal.

RECOMMENDATIONS

SEPARATION FROM NEIGHBOURS Siting with regards to neighbours is the most inexpensive way of preventing nuisance conflicts. Maintain good relations with neighbours. Accept that they have property rights and life style expectations. Let them know that they are considered in manure management decisions. Schedule land spreading when odour impact is minimal.

REDUCE ODOUR IMPACT For operations undergoing remodelling, rebuilding, or major expansion, manure management alternatives must be considered carefully. Often it's the attention to small management details that can make a difference. Such options are:

- Incorporate manure as soon as possible. Inject, if possible.

- Maintain sanitation and aesthetics around the facilities. The appropriate use of strategically placed visual screens and shelterbelts are recommended. The public should perceive a livestock operation as a clean, tidy, well managed business.

TECHNOLOGY AND MANURE TREATMENT New technologies are emerging that will provide management options to producers. Odour control systems involving manure aeration, anaerobic decomposition, oligolysis, manure additives, composting, and storage covers are all being developed to offer better methods of controlling odour production. Unfortunately not all will be economically feasible for many farms. With additional research and farm level demonstrations, these techniques may soon offer management options to individual farms that have problems.

Manure must be promoted as a resource. The more valuable it becomes, the more that can be spent on better handling methods.

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