

Odour Control Techniques

Many farmers are interested in finding ways of controlling odour on their farms. Reducing odour associated with hog farming will be instrumental to the success of our industry. Ontario Pork and other organizations worldwide are searching for ways to reduce odour. Sorting through the enormous amount of information is quite daunting. Ontario Pork and others in the red meat sector in collaboration with The Prairie Swine Center Inc. in Saskatchewan produced an Environmental Issues Resource Centre database. Much of the information in this article can be found on this database. I have also summarized information from the National Pork Producers Council, Odour Solutions Committee.

What causes Odours?

On pig farms, odours originate from the pigs themselves, manure within the building, manure stored in facilities and later applied in the fields. Odour emissions also come from feed products and feed processing. Swine odours are complex, as they result from the mix of more than 165 identified volatile compounds. Interaction between those compounds is not yet well known and understood.

These substances can be classified into different groups of chemical compounds such as volatile fatty acids, phenols, nitrogen derivatives and sulfur derivatives.

The level of protein and amount of roughage in the animal's feed ration affects the generation of some compounds. The manure-handling system in the barn, from the barn to the storage facility and later to the field, affects the rate of odour generation and the characteristic smell.

Site and Building Considerations

Siting considerations

In the preliminary stages of the development of a new hog operation, many factors must be considered, including the location of the site. Some general rules of thumb to follow when choosing a new site are:

- Ensure that there is adequate separation distance. A minimal separation distance to neighbours allows for odours dispersion without having considering any particular management practices that would further minimize odour emissions.
- Consider prevailing winds in site selection to minimize the frequency of odour transport to neighbouring residences.
- Make use of naturally occurring windbreaks, shelterbelts and topographic features to provide natural odour dispersion and visual screening.
- Obtain sufficient land suitable for manure application according to soil and plant requirements.

Building considerations

Building design and operation practices have a substantial impact on odour control. Pen cleanliness has a major impact on odour emissions in a room. Within the building, the soiling of surfaces and pigs with manure also increases the odour emission rate. Sources of odours in and around the building include:

- Wet, manure covered floors;

- Dirty, manure covered hogs;
- Spilled, moldy feed;
- Improper disposal of dead pigs;
- Deep manure pits under barn floors;
- Incinerators with incomplete combustion;
- Dust from feeders and barn surfaces resulting in higher levels of odorant as odour adheres to the dust and is moved outside the barn by the ventilation system;
- Increased room temperature increases emissions; and
- Feed preparation at the farm.

To reduce odourous emission:

- Ensure that pigs remain clean in the pens. If animals become dirty with manure, their body heat will promote the rapid release of odours.
- Pen scrapping, and removal of manure, reduces odour emissions and ammonia concentration in the room and its total emission into the environment.
- Regular washing and the use of easy to clean surfaces in barn construction considerably lower odour emissions.
- Limiting surface contact between ambient air and manure will help to reduce odours. Any steps, such as frequent manure removal to prevent anaerobic degradation of the manure within the building, will lower odour emissions.

Ventilation

Odours from ventilation air of livestock buildings can be a potential source of complaints from neighbours. The dispersion of gases and odours from the building depends upon the building shape, ventilation system, livestock numbers, manure management system and the conditions to be maintained in the building compared to the outside temperature.

The processes involved in odour emissions from a building are somewhat complex as they vary with the ventilation rate of the exhausted air. The lower the ventilation rate, the higher the odour concentration is going to be close to the building. However with higher ventilation rates, the odour is diluted in a much larger air volume. The impact on the surrounding neighbours is going to be different depending on the air dispersion pattern outside the barn due to wind speed and direction.

Central ventilation, which collects all exhaust air into an air stream, is being used in Europe in order to treat the exhausted air that leaves the barn with different techniques.

Technological developments

The following are various technologies that are currently being investigated. However, further research and development is required before they can be proven to be reliable.

Biofilters

Biofilters can treat the exhausted air released from the barn as they absorb odour compounds. With biofilters, air is pushed through a porous bed of organic material (compost, peat, straw, soil, etc) that is kept moist. Dust and gaseous compounds are retained on the surface of the medium as well as adsorbed into the organic material. Bacteria present or added to the material convert those compounds into less odourous substances. The microorganisms present feed on the

medium as well as on the nutrients present in the air that is passing through. Research results showed a 70% reduction in odour when compared to the levels of the air coming out of the barns with no treatment.

Current research on biofilters used under colder conditions is underway in Alberta, Ontario and Minnesota. Ontario Pork in conjunction with OMAFRA has initiated a biofilter study this summer.

Bioscrubbers

Bioscrubbers can be used to reduce odour emissions from outgoing ventilation air that has been centralized. Typically, these units are counterblow systems where water flows across a mat and the air to be treated is pushed through it. The unit is colonized with microorganisms creating a biological mat. The scrubbing water flowing across the mat regenerates and supplies the bacteria with substrate and collects dust particles, odour compounds and different gases. This system can remove up to 70 - 80% of the ammonia load from the barn. However, it requires a supply of fresh water, and the disposal of the recycled water at regular intervals. The hog industry has not been adopting this technology on a large scale due to its complexity and high cost.

Ozone generation

Research continues on the potential of ozone generation as a mean to reduce odours in pig barns. Ozone (O₃) is a naturally occurring substance generated by an electrical arc or ultraviolet radiation. The use of ozone generators in poultry and pig operations has been shown to reduce ammonia, hydrogen sulfide and other organic substances. Ozone oxidizes the organic substances, altering the compounds, thus reducing the odour characteristics. The ozone generator can be installed and used with existing ceiling ductwork distribution systems. Close monitoring of the ozone concentration in the building and adequate adjustment of the ozone generator system is necessary to provide a safe and healthy environment for the barn workers.

Storage and Treatment of Manure

Manure can be treated in the barn or at the storage stage.

Treatments

Basic research on odour compounds interactions and emissions are still needed before practical and economical methods for odour control can be implemented from a manure management point of view. Research is being funded in many parts of the world to develop reliable products or techniques to abate odours. Techniques in odour measurement and comparison are also still being developed and tested.

Pit additives

Pit additives vary greatly in their characteristics and modes of action. In many cases, the additive is a bacteria mix that will digest manure. Some additives will change manure consistency and homogenize it, others won't have any effect on the solid content. A recent survey showed that 78.9% of the 180 producers questioned used pit additives to solve their manure flow problems. Only 40.6% were satisfied with the odour reduction they obtained with the additives. Other pit additives could be classified as odour masking agents. Those additives can also be added directly in the manure tank before application. The addition of masking agents results in no change in the manure characteristics other than

changing its offensiveness. Some additives have a chemical action resulting in ammonia binding and also in the reduction of some bacterial activity. Some products (Bio-surge, Gold 2000, Pit Boss, Shac,) have been tested in research facilities and show some promise. However, more information is needed to better understand their range of application, and their limits within commercial farm operations.

Pork producers interested in the most recent results should contact the Prairie Swine Centre website at <http://adminsrv.usask.caa/psci>.

Perdue University Agricultural Air Quality Laboratory evaluated thirty-five storage pit additive products in an experiment supported by the National Pork Board. This 200 page report should be read in its entirety and is available on the National Pork Producers Website at www.nppc.org/ please look under the section entitled: (especially for producers).

High-rise swine barn.

Barns using this technology are being built across the U.S. A standard slatted floor hog barn using liquid manure is built over a manure storage filled with three to four feet of a carbon source, (usually straw). The manure storage floor is equipped with aeration ducts to dry the manure. All ventilation air is exhausted through this manure storage.

Ontario Pork and Ridgetown College are testing this technology in a barn built in the Exeter area.

Anaerobic digesters

Anaerobic digesters are large tanks used to anaerobically (without oxygen) decompose manure. Under controlled conditions, the digesters decompose the slurry, resulting in a less odorous product. Methane gas is produced in the digester and can be collected and utilized as an energy source. Digested pig slurry produces a less offensive odour than undigested manure while maintaining the slurry's nutrient value. The digester temperature, the manure loading rate, the amount of mixing, digestion time and the characteristics of the manure, affects methane production.

The limiting factors in complete anaerobic digestion are the high cost of the digester, the ability of this equipment to perform well under our cold conditions and the expertise required to operate it. Research is currently being done by a joint team in Quebec and Manitoba to develop a low temperature anaerobic treatment that would control odour emissions and could be easily implemented on farms under our cold conditions.

Currently there are 31 farm-scale digesters operating at commercial farms in the United States. Of these, 15 are at swine farms, 14 are at dairy farms, and 2 are at poultry farms. Typically they require a capital cost of approximately \$350,000.00 U.S. and produce about \$30,000.00 worth of electricity per year.

Storages

Earthen manure storage

Earthen manure storages are sometimes used to store liquid manure. This type of storage system is relatively inexpensive and requires little maintenance. The bacterial action occurring in manure storage can be divided into aerobic and anaerobic, depending on oxygen availability in the manure.

Anaerobic storage

Anaerobic digestion occurs in manure in the absence of oxygen. Bacteria in the manure digest organic and other matter. This decomposition results in simpler compounds. During anaerobic microbial decomposition many compounds are produced. The most notable compounds are carbon dioxide, methane, ammonia and hydrogen sulfide.

Under cold conditions, bacterial activity is reduced, and can even stop, so complete anaerobic digestion cannot be obtained. This situation results in odour emissions from the storage facility particularly when the manure is mixed and if the storage facility is not covered.

Aerobic storage

Aerobic digestion occurs in manure in the presence of oxygen. Aerobic bacteria break down organic material much faster than anaerobic bacteria. Aerobic bacteria in the presence of dissolved oxygen convert organic matter to a stable form such as carbon dioxide, water, nitrates and phosphates.

Aerobic treatment results in reduced odour emissions, but can result in increased ammonia emissions. Loss of ammonia, which contains nitrogen, reduces the fertilizer value of manure and can contribute to acid rain. Aerobic conditions in earthen manure storage are obtained by: bubbling air or oxygen through the slurry, mixing the slurry mechanically, or pumping the slurry through the air. In order to stabilize and deodorize the manure, aeration has to be sufficient and long enough so that all organic material is degraded. Aeration by circulation can be achieved by impellers that turn and create a vortex in the manure allowing for an even distribution of oxygen.

Some storages are experimenting with wind driven aerators. Further research is needed to determine if there is any benefit for these types of low cost, low energy systems.

Covers

Covers can be very effective methods to reduce odours from manure storage units. Prairie Agricultural Machinery Institute (PAMI) has concluded that barley straw can provide excellent odour control as long as the straw floats and remains dry. With a straw applicator to provide uniform coverage, 6 - 10 inches of good quality barley straw has been shown to decrease odour by 90 -95%.

When 15% of the earthen manure storage area has open liquid because of straw sinkage, reapplication of straw would be necessary. Generally only one reapplication within a year is required.

Before using barley straw on the surface of liquid manure, ensure that the manure removal and application equipment that is generally used is capable of handling the extra fibrous or organic material. This may require a chopper blade on the agitator or a rotary cutting and /or distribution system prior to the slurry injector.

Flexible - type covers

Balloon cover on a concrete manure storage system

Source: Prairie Swine Centre Inc.

At Prairie Swine Centre, the use of a hypalon roof covering tarp on a concrete storage tank has proven to be a very effective and economical method of reducing manure odour during storage. The plastic tarp is sealed tight around the perimeter of a concrete tank and inflated using a low-pressure blower requiring the power equivalent of a 250-watt light bulb.

In the Prairies, some developments are currently done on a flexible cover using negative air pressure to secure it over earthen manure storage facilities. Other

floating devices are being developed and tested for earthen storage facilities in the U.S.A.

Compost

Composting is an aerobic process that requires oxygen. The organic material degradation is done by microorganisms under controlled conditions. Nitrogen and carbon are essential nutrients for growth and production of microbial cells in the decomposition of complex organic compounds. The amount and form of nitrogen required and carbon source used (wood shavings, straw, etc.) varies with the type and concentration of material to be treated. For composting pig manure a carbon to nitrogen ration around 30:1 and moisture content of 50 - 60% is reported to be effective. This requires the addition of material such as straw, leaves, sawdust or paper to the liquid manure.

The end product is a more stable form of organic matter and nitrogen. The nitrogen in the compost is stabilized into organic forms that are less volatile allowing for more nitrogen to be retained for use in crop production and less volatile odourous compounds produced.

Aerobic composting will not produce high levels of objectionable odours if properly managed. The primary end products of aerobic decomposition are carbon dioxide, water and heat. If the pile contains adequate amounts of material such as straw, proper temperature and aeration, little odour will be given off. By aerating the manure using a mechanical turner, the rate of decomposition is greatly increased. However, cold weather can slow down the microorganism activity considerably.

Challenges to composting pig manure include the low solids content (typically 5% total solids) but with the addition the correct amount of materials such as sawdust, or liquid-solid separation composting can be accomplished.

More information on composting is available by contacting Ron Fleming at Ridgetown College of Agricultural Technology at Ridgetown, Ontario.

Constructed wetlands

Wetlands

Wetlands have the natural capability of filtering out nutrients such as nitrogen, phosphorous, and potassium, from the water. Constructed wetlands mimic the functions of natural wetlands. Plants, such as cattails and bulrushes utilize these nutrients resulting in cleaner water.

Proper sizing and management of a wetland area results in cleaned water that can be released to the natural watercourse, as the nutrients have been retained in the vegetative material. Because wetlands do not function during the winter, constructed wetlands will need to be sized to complete all of the treatment in a 6-month period or less.

The limiting factor of constructed wetlands is that there is a high capital cost involved in building such a system. Further research is required to determine the feasibility of wetlands to manage manure.

Cost of different odour management techniques

As mentioned, simple measures can be taken to control odours including having adequate separation distances and keeping the facility clean. If any particular techniques are used to reduce the impact of odours, an associated cost comes with it. The following figures attempt to give an idea of the magnitude of those costs.

The values given in Table 1 have to be used with caution, as they were gathered from different sources in North America and Europe and do not represent a controlled economic comparison.

| Table 1 MANURE ODOUR MANAGEMENT COSTS | |
|---|--|
| TECHNOLOGY | ASSOCIATED COST CAN \$ |
| Feed additives and Manure additives | \$0.95 per pig produced (AURI, 1997) \$12.93 per sow-place \$2.45 per pig-place (Guingard et al., 1998) |
| Straw manure storage cover | Straw \$20/1000sq ft. or \$169.74/hour - 5 hrs for 8 Million gallon Earthen Manure Storage - all annual costs (PAMI, 1999) |
| Balloon manure storage cover | \$5000 + \$2000 labour (5 - 10 years) +electricity (Zhang, 1996) |
| Biofilters | \$0.40/ piglet produced in farrowing (Nicolai and Janni, 1997) |
| Bioscrubbers | \$12.75 to \$24.15 per pig produced (Lais et al. 1997) |
| Ozone generator | \$45 000 (10 to 20 year life expect.) \$1400 elec. + \$500 maint. / Year (Envron, 1999) |
| Anaerobic digester and Aerobic systems | 1.07¢ to 2.17¢ / gallon of manure treated (ITP, 1998) \$5.72 per pig produced (CRIQ, 1994) |
| Constructed wetland | \$20 000 to \$30 000 per acre for compacted and clay lined installation |
| | \$6 000 to \$12 000 per acre for unlined installation (SAF, 1999) |
| Manure injection | 1¢ per gallon of manure injected (PAMI, 1999) |
| Mixed treatments (separation then biofilters for liquids an anaerobic treatment for solids) | 2.27¢ to 9.09¢ / gallon of manure treated (Gingras and Pigeon, 1998) |

The following information from the National Pork Producers Council is applicable to every producer.

Odour from land application

Many nuisance complaints due to odour occur just after manure has been applied to agricultural land. Such spreading creates a large surface area of applied manure to interact with the atmosphere.

Tillage

Use of tillage equipment to incorporate manure that has been surface applied is one way to reduce the interaction of manure with the atmosphere, and thus reduce odour. The sooner manure can be incorporated after spreading; the less time there is for odour release. A similar technique possible with liquid manure is to inject the manure below the soil surface with a knife or sweep assembly, or incorporate it with a series of disks as the manure is applied on the soil surface. This will be effective in reducing odour but may not be acceptable in a conservation tillage program.

Ontario Pork in conjunction with Agriculture Canada and Nuhn Industries are involved in research surrounding injection techniques. Preliminary results show that manure can be injected successfully. This technique reduces odour while at the same time, keeps manure out of the ground water.

Low Trajectory application

When surface applying by irrigation or broadcasting from a spreader, use of a low trajectory spread pattern decreases mixing with the atmosphere and thus reduces odour release.

Timing

Try to carefully select the time when manure will be land applied. Careful timing can decrease the opportunity for neighbors to experience the odour released. Avoid spreading just prior to weekends or holidays when people are involved in outdoor activities. Give special consideration to events planned at recreation areas near the land receiving the manure. Also pay attention to the wind direction and avoid spreading on days the wind is blowing toward neighbors or recreational areas. Time of day also has an effect. Morning spreading is preferred because as the air warms it rises, promoting manure drying and lifting the odour upwards for mixing and dilution in the atmosphere.

Avoid high humidity days or just before a rain because the humidity causes odours to linger. If possible, it is best to conduct all land application of manure within a short time period rather than to extend the task. This will decrease the duration of odours.

Neighbor relations

Personal interaction with neighbors has very little to do with odour control, but may be the most important part of avoiding complaints. Producers who have a cooperative public attitude receive few odour complaints. Open communication is important; hiding something generally arouses suspicion. Always be courteous when dealing with neighbors, even if their requests are unrealistic. Alert neighbors to plans for spreading manure and discuss any plans they have for outside activities. One farmer uses post cards to notify neighbors of proposed spreading. If they are planning an activity they are asked to call the farmer. This gives the neighbors a feeling that they have some control over the situation and it is not imposed without their consent. Another suggestion has been to even offer a motel room to neighbors during times when odours will be intense. The offer itself may be the difference between happy or unhappy neighbors. All spreading activities should be documented so a record is available in case a problem should develop. Determine the cause of any complaint and work to correct it. Good public relations go a long way toward improving acceptance of odours generated by livestock production.

Conclusion

Livestock production does produce odours, and there is no way to eliminate those odours entirely. The severity of those odours is dependent on the frequency and duration of occurrence and the intensity of the odour, in addition to the perception of the people experiencing the odour. Everyone's perception is different, as what may be a nuisance to one person may be pleasant to another. Fortunately, there are a number of management practices that can be implemented to reduce odour problems. The most important of these is general cleanliness of animals and buildings. Frequent manure removal also decreases odours, as some odours are generated while manure decomposes. Proper site selection for production facilities is also important, with distance from neighbors one of the most important factors. Increased distance from neighbors may be the easiest and most appropriate method to minimize odour complaints. Many products are being developed and promoted to reduce odours released from production facilities and

manure storage units. Careful selection of when to apply manure to agricultural land and use of practices such as injection or incorporation of manure goes a long way toward reducing odour complaints. Open communication and cooperation with neighbors develops good relationships, decreasing complaints and promoting acceptance of livestock production.