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A Review of the Ammonia Issue and Pork Production

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Summary and Implications

During the last few decades, an increasing interest in, and respect for, the environment has arisen. This has consequences for livestock production. Air can become polluted by noxious odors from animal husbandry. A particular example is odor emission from pig buildings, because in several parts of the world pig production has become highly specialized, industrialized and concentrated geographically. Air quality in pig facilities, as it influences the well-being of animals and workers, has become a major concern for pork producers. Odors emanating from pig slurry are an increasing source of environmental pollution as well as a nuisance to the human population in the vicinity. Emission regulations that establish a maximum acceptable emission rate for individual pollutants released from a source are currently under debate for production agriculture in several regions throughout the United States. To meet increasingly stringent air quality demands, pork producers will be obligated to adopt technologies and innovations in production to minimize the concentration of pollutants present in the odor emitted from pig facilities. The purpose of this review is to discuss how ammonia is produced, the human health concerns involved, and the control of ammonia and odor emission.

How Ammonia is Produced

The first step in air quality maintenance associated with livestock production is the definition of sources responsible for the emission. Odor emission from swine facilities is due to fermentation of manure. Pig manure is predominantly a mixture of urine and feces, and contains undigested components of the diet, endogenous end products of digestion, and bacteria from the lower gastrointestinal tract. Manure contains a variety of simple and complex organic compounds and inorganic compounds, and may contain feed additives, depending on the dietary components. Odorous volatile organic compounds can be produced. The gases of most concern in swine buildings are ammonia, carbon dioxide and hydrogen sulfide. These gases are a major source of indoor air contamination. Ammonia is a gas with a very sharp odor. The odor is familiar to most people because ammonia is used in smelling salts and household cleaners. A major source of ammonia emission is the metabolic processes of producing urea, which is excreted via urine. Urea is converted into ammonia and carbon dioxide by the enzyme urease, present in feces. The most important factors affecting this process are the urinary urea concentration, pH and slurry temperature. Ammonia volatilization is a process that depends on factors such as concentration of ammonia, air speed in the building and ammonia and dry matter content in the manure. Most of the ammonia in the environment comes from the natural breakdown of manure and from dead plants and animals.

Health Concerns About Ammonia Emission

Excessive ammonia levels inside swine facilities can pose a direct hazard to animal caretakers and the animals themselves. The Agency for Toxic Substances and Disease Registry and the Environmental Health Center have reported several harmful effects of ammonia emission on human health when people are exposed to much higher than normal concentrations in swine buildings where the air is poorly ventilated. These effects include coughing, eye irritation, lacrimation, a burning sensation, laryngitis, severe pulmonary and gastrointestinal irritation, nausea and vomiting, diarrhea, abdominal pains, pulmonary edema, dyspnea, bronchospasm, chest pain, blisters and cold and clammy skin. Ammonia gas releases heat as it dissolves and can cause thermal injury. Exposure to high concentrations of ammonia produces severe burns of the cornea and upper airway. Populations at special risk of exposure to ammonia include individuals with reduced liver function, corneal disease, glaucoma or chronic respiratory diseases. Individuals who spend several hours each day in swine facilities risk suffering some of these symptoms if the air quality inside buildings is poor.

Ammonia emission also affects animal health. Ammonia can cause tissue damage in swine farms where pigs are confined. Ammonia levels of 50 ppm for three hours can produce coughing; eye, mouth, and nose irritation; and poor weight gain and feed intake in pigs. These effects can reduce growth performance, pig survival and sow reproduction. Although the current standard for safe ammonia levels is 25 ppm, recent research reports indicate that maintaining a level of no more than 10 ppm may help prevent health risk in both pigs and humans.

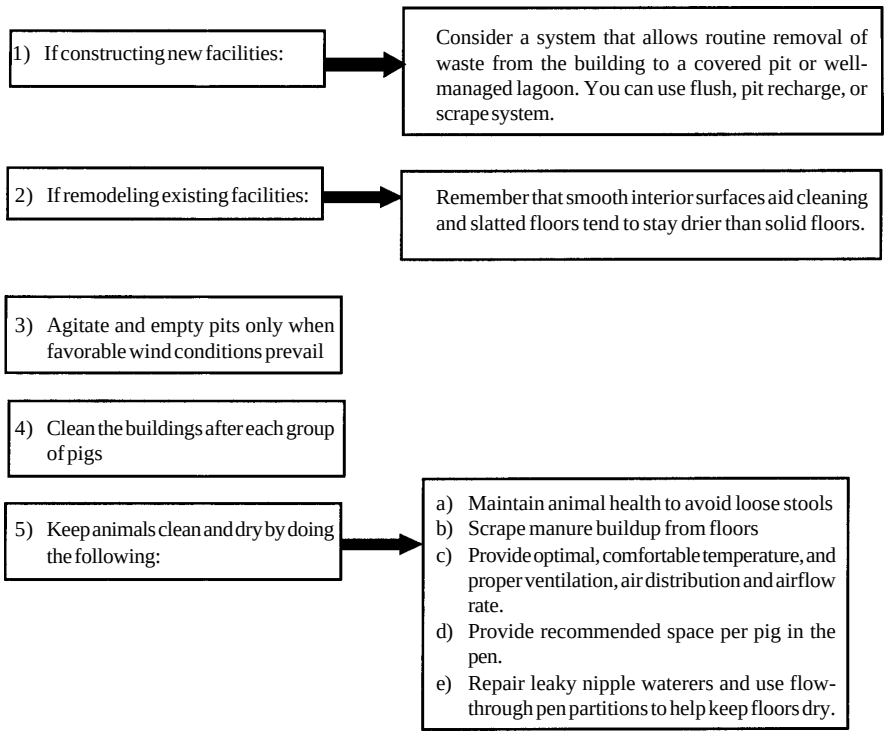

Figure 1. Recommendations that can be considered by pork producers to reduce odor emission in swine farms.

Regulations about Ammonia Levels

The Occupational Safety and Health Administration (OSHA) has set a permissible exposure limit for ammonia of 50 ppm, or 35 mg/m^3, time-weighted average, and a short-term (15 min) exposure limit of 35 ppm for ammonia. The National Institute for Occupational Safety and health (NIOSH) recommends that the concentration in workroom air be limited to 50 ppm for five minutes of exposure.

Under the Emergency Planning and Community Right-to-Know Act, releases of more than one pound of ammonia into the air, water and land must be reported annually and entered into the National Toxic Release Inventory. Emission regulations establishing a maximum acceptable emission rate for individual pollutants released from a source are currently under debate for production agriculture in several regions in the United States. To meet increasingly stringent air quality demands, individual pork producers will be obligated to adopt technologies and changes in production design that minimize the concentration of pollutants in the emissions stream from swine facilities. The National Pork Producers Council has indicated that there are no federal regulations directly related to the control of odors from swine facilities. The concern is about state and local laws and ordinances relative to odors. There also is a law of common nuisance, however, which roughly states that every person has the right to the enjoyment of his/her property without unreasonable interference. It is this nuisance law that has been of greatest concern to pork producers as they have dealt with the perception of odor problems from their farms.

Alternatives to Reduce Ammonia and Odor Emission from Swine Facilities

Although ammonia is neither the only source of odor nor the most offensive, studies in Europe have indicated that measures applied to reduce ammonia generally reduce odors from the other compounds as well. In land application of manure, for example, reducing ammonia emissions by 10 units was found to reduce odor by 70 units.

Procedures such as reducing the concentration of ammonia in the slurry (dilution), reducing the temperature of the slurry (cooling), reducing the emitting surface and reducing the pH (acidification) are principles proposed to reduce ammonia emission. Other alternatives include dietary manipulation including: a) lowering dietary crude protein and supplementing with crystalline amino acids, b) adding fiber sources such as small amounts of soybean hulls or dried sugar beet pulp to lower crude protein, c) adding calcium salts and feed additives such as sarsaponin, a natural extract of the yucca plant, which has been shown to reduce ammonia.

Some recommendations from The Department of Agricultural and Biological Engineering at Purdue University that can be considered by pork producers to reduce odor emission in swine farms are in Figure 1.

Current Research

The University of Nebraska-Lincoln Department of Animal Science has been researching methods to reduce ammonia emission from swine facilities. We have previously demonstrated that reducing dietary crude protein concentration can produce a major reduction in odor and ammonia in swine facilities. Currently, we are studying modifications in nursery diets to reduce ammonia and hydrogen sulfide gases. Feed additives that are being investigated are *Yucca schidigera* extract and calcium chloride. This research offers additional possibilities for reducing ammonia and odor emission from pig facilities.

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