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Gas Removal from Swine Housing

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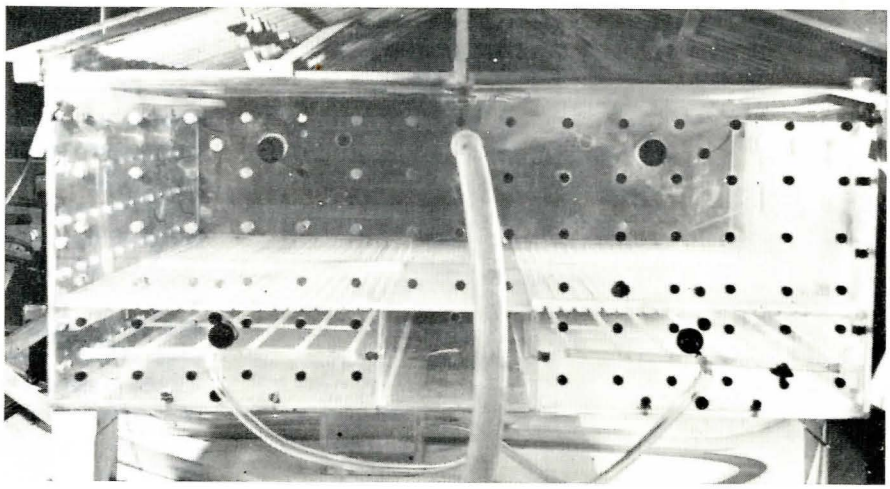

Engineers use this model to evaluate ventilation systems.

Gas Removal from Swine Housing

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Swine producers are concerned with how to decrease odors and noxious gases in completely enclosed animal production units with slotted floors.

This concern has probably been caused by public awareness of air pollution, respiratory discomfort of some humans while working in a swine housing environment and the reaction of pigs to gases produced in the storage pits.

Gas Production

The most important gases generated from stored manure during anaerobic decomposition are carbon dioxide (CO_2), ammonia (NH_3), methane (CH_4) and hydrogen sulfide (H_2S).

Carbon dioxide: Carbon dioxide is a colorless, odorless gas about 1½ times as heavy as air and highly soluble in water. Normal atmosphere contains about 300 ppm (parts per million) (0.03%). In a ventilated swine confinement unit the concentration has been reported to be between 600 and 1,800

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Gas Removal

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ppm because of the CO_2 produced by the respiration of the pigs and from manure decomposition. This is well within the recommended safe limits of 5,000 ppm for man. Air containing 40,000 ppm causes the pig to have deep, fast breathing.

Ammonia: Ammonia is colorless, has a pungent odor, is lighter than air and is highly soluble in water. The problem of ammonia is less with slotted floors than with solid floors because of its high solubility in water.

Concentrations in confinement hog buildings have been measured as high as 35 ppm in a ventilated building and 176 ppm in an unventilated building. The upper recommended working limit for humans is 50 ppm. Because it is an irritant, ammonia tends to induce sneezing, salivation and loss of appetite of pigs at high concentrations of 100 to 200 ppm.

Methane: Methane is colorless, odorless, and about one-half as light as air. Pigs suffer no harmful effects from inhaling methane. Since it is considerably lighter than air, it will dissipate rapidly if there is adequate ventilation.

Hydrogen sulfide: Hydrogen sulfide is colorless, smells like rotten eggs, is somewhat heavier than air and is soluble in water. Hydrogen sulfide is one of the most toxic gases to humans and animals associated with liquid manure storage. It is both an irritant and an asphyxiant.

For humans, low concentrations of 20 to 150 ppm cause severe irritation to the eyes and respiratory tract, if inhaled for an hour. The eyes are affected after 6 to 8 minutes of exposure. Exposure to 500 ppm for 30 minutes will affect the nervous system and cause severe headaches, dizziness, excitement, and a staggering gait.

According to the American Conference of Governmental Industrial Hygienists, high concentrations of 800 to 1,000 ppm cause immediate unconsciousness and death through respiratory paralysis unless artificial respiration is immediately given.

Pigs are made uncomfortable by prolonged exposure to low concentrations of hydrogen sulfide. Pigs exposed continuously to at least 20 ppm develop fear of light, loss of appetite, and nervousness; 50 to 200 ppm cause vomiting, nausea, and diarrhea. In acute poisoning, hydrogen sulfide acts so rapidly that there are few symptoms of imminent danger. Sudden nausea and unconsciousness are followed by death at concentrations of 800 ppm and above. The pigs may recover completely from exposure to high concentrations, but they may be susceptible to pneumonia and other respiratory diseases.

A concentration of 0.09 ppm in a normal ventilated confinement building rose to 0.28 ppm after the ventilation was shut off for 6 hours. Dangerous concentrations can be released by vigorous agitation of stored liquid manure. Concentrations reaching 200 to 300 ppm have been reported a few minutes after pumping out a storage pit and as high as 800 during vigorous agitation.

A farmer can determine the presence of hydrogen sulfide by noting the black accumulations of copper sulfide that form on copper thermostats and electrical wiring, the white deposits of zinc sulfide on galvanized steel, and the black discolorations of lead-pigmented white paint.

Removal of Odors and Gases

One method of getting rid of odors and noxious gases is through the use of oxidation ditches which, when operating properly, give off an earthy smell.[1] For existing swine facilities it is difficult to implement the use of an oxidation ditch. For existing facilites, the use of the ventilation system to draw air from the pit area shows promise and is presently being studied.

Ventilation—In designing a ventilation system for the removal of gases from the pit area, the engineer needs to: 1. Determine the size of exhaust duct underneath the slotted floor to pick up the pit gases.

2. Determine the fan capacity so as to match the quantity of gases being produced by the amount of air being exhausted from the pit area.

3. Determine the amount and size of openings in the exhaust distribution duct.

The openings in the duct should be adjustable so as to allow regulation of the air pattern underneath the pit area. The air pattern can be evaluated with the use of smoke sticks.[2] The smoke sticks contain a chemical that reacts with the moisture in the air and forms a white smoke that allows you to follow the air circulation pattern.

With an exhaust ventilation system there appears to be some corrosion problems of exhaust fans underneath the pit area. A positive pressure system is being used by some companies with all the air going through the exhaust ports in the pit area. This decreases the corrosion of fans but might cause drafts to occur at the level of the animal if not properly designed.

Model Research Studies—Studies concerning the control of odors and noxious gases in swine confinement units have been conducted with a 1/12 plexiglass scale model of an existing swine environmental controlled building at the Northeast Station.

In this study, five different air flow distributions, four different inlet settings and four different outlet locations of fans were used. Ammonia gas was distributed below the slotted floor as would be found in a confinement unit. As more air was exhausted below the floor level, the concentration of ammonia gas above the floor decreased. However, there was no statistically significant difference between all the air exhausting below the floor and ⅔ of the total exhausted air being exhausted below the slotted floor.

It was found that the inlet settings influenced the concentration of ammonia above the floor. Field

[1] "Oxidation Ditches and Swine Waste Treatments by O. E. Cross and E. A. Olson in this *Nebraska Swine Report*.

[2] #15-049 Smoke Sticks; E. Vernon Hill Incorporated, P.O. Box 14248, San Francisco, California 94114.

studies are presently being conducted to substantiate some of the findings of the model research studies. Some systems also are in the construction process and formulative process to test different pit ventilation systems.

Management Cautions

1. When the ventilation system stops in a tightly constructed building full of pigs, the pigs may die from asphyxiation because of lack of oxygen and increased carbon dioxide, or from heat stress. Conditions become critical when the oxygen content drops from the normal 21% to 10% or below. A confinement unit should have some type of safety or warning device to notify the operator if the mechanical ventilation system fails.

2. Vigorous agitation of liquid manure stored for some time can release noxious gases and create dangerous or even lethal conditions. If manure stored under slotted floors is agitated while the pigs are allowed to stay inside the building, extreme care should be taken to ventilate the building and the pigs should be watched for any signs of ill effects. Instances have been reported of pigs dying during the agitation of manure, and an operator in Scotland was overcome during the emptying of a storage pit.

3. The air in a manure storage pit is not safe to enter without first ventilating the pit. Both hydrogen sulfide and carbon dioxide are heavier than air and will tend to accumulate in the pit. Several human deaths have been reported when operators entered a covered manure pit, were instantly overcome, and drowned in the remaining liquid waste. Never enter a manure storage pit unless it has been properly ventilated and you are equipped with a proper mask. Always have someone stand by with a rope attached to you to pull you out at the first signs of dizziness.

Portions of this material have been adapted from "Swine Housing and Waste Management" by Arthur J. Muehling, University of Illinois.