



Food, Agricultural, and Biological Engineering, 590 Woody Hayes Drive, Columbus, OH 43210

How to Work Safely Around Manure Storages

Lingying Zhao

Extension Agricultural Engineer

A 2007 tragedy at a Virginia dairy farm, which caused five deaths due to gas emissions from the manure storage facility, is a reminder of the importance of understanding and managing gas emissions from animal manure storages, especially intensive, enclosed, large-scale manure storages. Besides potential dangers associated with these facilities, people wonder about seasonal fluctuations in odor levels and why more odor problems occur in July and August.

During the natural process of organic matter degradation, several gases are released from manure and other farm waste. As animal farms evolve towards larger and more concentrated operations, manure storages become larger and concentrated. Manure management practices have to take odor and gas emissions into consideration.

It becomes critically important to understand what is emitted from manure storages, how the emissions affect health and safety, and how to manage and safely work in this environment. This fact sheet is written to help livestock producers and workers understand the dangers associated with emissions from manure storages in order to prevent further tragedies.

What Is Emitted from Animal Manure?

Gaseous emissions from manure include ammonia (NH_3), hydrogen sulfide (H_2S), nitrous oxide (N_2O), methane (CH_4), carbon dioxide (CO_2), volatile organic compounds (VOCs), and odor. Ammonia is a colorless gas that is lighter than air and has a sharp pungent odor. It is mainly released from fresh manure, but during manure storage, undigested nitrogen in feces is mineralized to ammonia.

Hydrogen sulfide is a colorless gas, heavier than air, and has the odor of rotten eggs. It is generated when organic matter in manure decomposes under anaerobic conditions.

Nitrous oxide is a greenhouse gas. It results from the microbial processes of nitrification and denitrification of manure nitrogen.

Methane, a major component of natural gas, is odorless and produced by anaerobic microbial decomposition during manure storage. High temperature and moist conditions promote methane production. Methane is a greenhouse gas and flammable.

Carbon dioxide is a part of natural air, odorless, and lighter than air. It is mainly caused by animal breathing and manure decomposition.

Volatile organic compounds (VOCs) are chemicals that easily vaporize at room temperature. Anaerobic decomposition and transformation of organic matter and animal waste generate a large number of volatile organic compounds.

Odor is an unpleasant smell caused by more than 330 odorous VOCs and gases, such as hydrogen sulfide and ammonia. For more detailed gas and odor emission information, please see Ohio State University Extension Fact Sheet, *Understanding Air Emissions from Animal Feeding Operations*.

How Do the Gases and Odor Emissions Affect Safety and Health?

Intensive gas and odor emissions from manure deteriorate air quality. Air quality directly affects the health of animals and human workers and farmers, depending on

the levels of exposure. Poor air quality beyond the property line affects the health of farm neighbors.

Ammonia and hydrogen sulfide are toxic gases that, even at low levels, such as 50-100 ppm (parts per million), might cause eye, nose, throat, and respiratory irritation. Ammonia exposure levels around 5,000 ppm for 30 minutes can be fatal.

Hydrogen sulfide has a strong rotten egg smell at low levels; however, when hydrogen sulfide reaches 100 ppm, it quickly destroys the sense of smell. Exposure to high levels of hydrogen sulfide causes fluid in the lungs, respiratory arrest, and death. A hydrogen sulfide exposure of 500-1,000 ppm will rapidly cause unconsciousness and death. At enclosed manure storages, especially during manure agitation, hydrogen sulfide levels can easily reach 1,000 ppm.

When toxic gases are colorless and odorless, they are extremely dangerous, particularly at high levels, as there might not be any early warning signs of their presence.

Nitrous oxide, methane, and carbon dioxide do not have toxic effects. However, methane is flammable and explosive when mixed with air or oxygen. High concentrations of nitrous oxide, methane, and carbon dioxide can cause oxygen depletion in air and asphyxiation. Carbon dioxide can displace the oxygen supply in the bloodstream and result in unconsciousness and death. At moderate concentrations, they cause drowsiness, headaches, shortness of breath, and dizziness.

Odor is a nuisance that causes major public concern because everyone has an odor detection sensor — a nose. After odor is emitted, it will disperse in the atmosphere. A breeze may transport strong odors downwind to neighboring areas and cause complaints about quality of life and health.

When Is the Worst Case Scenario?

The process of microbial degradation of manure is governed by many environmental factors, such as temperature, humidity, and airflow. Research at The Ohio State University showed that temperature is the most important factor causing high gas generation. Large seasonal variations occur in gas and odor generation from manure storages. The gas and odor release rates reach peaks in July and August. Therefore, warmer months are the critical time to pay attention while working around the manure storages.

High wind speed across the manure surface causes high rates of gas and odor release. So, if there is no air exchange, using fans at a manure storage can make the gas emission problem more dangerous. Only fans that bring fresh air to the manure storage will reduce the high concentrations of gas and odor to make the work environment safer.

Also, humid environment and wet manure generate more gases and odor. Therefore, extra attention is required when entering storages with wet solid manure or liquid manure.

Finally, special manure handling events, such as agitation or emptying, normally cause significant gas and odor release. The gas and odor levels can be thousands of times higher than normal levels. Special warnings should be posted and proper procedures should be followed when working around manure storages during agitation and emptying.

Summary and Tips

Here are key points and safety tips from the National Safety Council.

- It is very important for producers and workers to understand the performance of manure storage ponds and to adopt proper manure management and handling procedures, especially during hot months, and manure agitation and emptying.
- Most gases are like air, which is colorless and invisible. Some gases are odorless as well. So, don't rely on senses alone to judge the situation. Use monitoring equipment to determine the level of dangerous gases present in the manure storage areas before working around them.
- Ventilate the manure storage if possible, but don't trust that ventilation alone will make the space safe. Because hydrogen sulfide and carbon dioxide are heavier than air, they cannot be easily removed from the lower part of the storage by ventilation.
- Label the manure pit and manure storage areas to warn of the gas hazards.
- Never enter a manure pit alone.
- A self-contained breathing apparatus must be worn when entering a manure storage area, and the person wearing it should be trained in its use.
- A safety harness should also be worn, and personnel should be available outside the storage area to assist if needed.

References

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Keith L. Smith, Ph.D., Associate Vice President for Agricultural Administration and Director, Ohio State University Extension
TDD No. 800-589-8292 (Ohio only) or 614-292-1868

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