Farm Safety – Manure Handling

Hazards of manure handling – Hydrogen Sulfide (H_2S)

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The most nutrient efficient and environmentally friendly way to recycle livestock waste is to withhold field application of the wastes until such time as the soil microflora can convert the nutrients and the plants can take up those nutrients. Unfortunately, in the northeast this is a window of only six to eight months. For the remainder of the year the waste must be stored in concrete, steel, or earthen manure storage facilities.

The Problem

During storage bacteria and other anaerobic processes breakdown the constituents of the waste and/or reform them into noxious compounds. Some of these compounds are potentially toxic gases or asphyxiants such as methane (CH_4), ammonia (NH_3), carbon monoxide (CO), carbon dioxide (CO_2), and hydrogen sulfide (H_2S). (See table 1) Hydrogen Sulfide is especially important as it is heavier than air and can accumulate in dangerous concentrations. Any extra source of sulfur (i.e. – gypsum bedding products) has the potential to increase H_2S production.

Some of the gas produced may remain in solution while in storage, especially if there is a tight, fibrous crust on the surface of the storage. These gases are released in masse when the storage is agitated to homogenize the contents for proper nutrient application prior to emptying.

H_2S is of particular concern because direct exposure can be immediately dangerous to life and health (IDLH) of humans and livestock at concentrations of only 100 ppm. H_2S is heavier than air and so will accumulate in confined spaces. It is considered immediately fatal at 1000 ppm, a concentration that can occur even spaces that are not confined.[1]

Best Management Practices

H_2S cannot be eliminated, so it must be managed to minimize the risk and maximize the safety of personnel and livestock. Methods of managing this fatal gas are:

- Consider prevailing winds, and site exterior storages downwind of livestock facilities and residences, as well as, away from neighboring developments.
- When possible, locate primary storage agitation points on the windward side. Secondary points may be accessed after initial agitation and gas release.
- Keep all nonessential personnel – kids, pets, etc. – away from the storage especially during agitation and emptying.

Table 1. Characteristics and risk amounts of the manure gases ammonia, carbon dioxide, methane, and hydrogen sulfide.
*(Adapted from Donham et al., 2010. and National Ag Safety Database, n.d.*Occupational Safety and Health Administration)*

Gas Characteristics	Ammonia (NH_3)	Carbon Dioxide (CO_2)	Methane (CH_4)	Hydrogen Sulfide (H_2S)
Color and Odor	Colorless, Pungent	Colorless, Odorless	Colorless, Odorless	Colorless, Rotten Egg Smell
Heavier or Lighter Than Air	Heavier	Heavier	Lighter	Heavier
OSHA Long Term Exposure (8-Hour Work Period, Max. Exposure ppm)	25	5,000	1,000	10
OSHA Short Term Max. Exposure (ppm)	35	--	--	15 (evacuation recommended)
Death Exposure (ppm)	10,000+	260,000+	50,000 (asphyxiation)	600+

• Closely monitor all personnel involved in the manure handling operation. Immediately remove anyone experiencing symptoms of nausea, eye irritation, respiratory distress, lightheadedness, and/or loss of the sense of smell. If working alone, make sure others know of your location.

• Consult your physician if you have been exposed to H_2S or NH_3, especially if it has caused noticeable distress.

• Agitator recirculation pipe nozzles should be submerged during agitation to minimize gas and odor release.

• Manure transfer pipes connected to a building must have a water seal, gas trap, or other device to prevent storage gasses from re-entering the building.

• Under-barn storages require a ventilation system that draws air from the livestock area, through the storage, and exhausts the gases outside.

• Buildings above manure pits should be ventilated such that no air is drawn into the building from the headspace below.

• Remove animals from facilities with interior storages prior to agitation and emptying. If this is not possible, increase ventilation rates to maximum and monitor animal behavior through windows or curtains.

•Maintain a minimum of 1' of head space between the manure surface and the underside of slats and covers to facilitate storage ventilation.

• If the 1' minimum head space is not maintained withdraw contents to 1' or more of head space prior to agitating.

• Ventilate pit continuously during manure removal and for at least 12 hours afterward.[2] Ventilation rate should be 1.5 times the empty pit volume per minute.

• Pit ventilation exhaust points must be away from pit pump-out access points.

• Inspect pit fans and ducts annually and service as required to ensure air exchange capacity is retained.

• Rescue equipment such as harnesses, ropes, respirators, and block and tackle should be located near the manure storage area. The location should be clearly marked.

• Specialized equipment such as self-contained breathing apparatus (SCBA) should only be used by those trained in its proper operation and maintenance. Untrained personnel should not purchase, borrow, or attempt to use such specialized equipment in life threatening environments.

• Gas detection equipment such as detector tubes and/or instruments designed to detect combustible gases and hydrogen sulfide should be available and located in a warm, dry area. These often have expiration dates and must be periodically replaced.

With careful management, manure storage can be utilized to improve water quality effectively and safely. Farms should remain vigilant in understanding the hazards of manure storages and ensure all employees understand the gases and precautions needed to work with them.

FACT SHEET SERIES: Farm Safety – Manure Handling
Part 1: Hazards of Manure Handling – Hydrogen Sulfide (H_2S)

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[1] Manure Storage Safety, ASAE EP470.1, OCT2011 (R2016)
[2] IBID