

SAFETY RISK FROM MANURE STORAGE OF DAIRY COWS BEDDED WITH GYPSUM

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Human and cattle deaths have prompted investigation into what is causing dangerous conditions during otherwise routine manure handling procedures on farms. This brochure provides background and findings from on-farm monitoring of dairies using gypsum as stall bedding where a link has been found to highly toxic levels of hydrogen sulfide gas during manure movement and agitation.

GYPSUM – ANIMAL WELFARE AND AGRONOMIC IMPROVEMENT

Gypsum recycled from manufacturing and construction waste provides a bedding source for the dairy industry. Gypsum can be used as 100% of the bedding or as a bedding additive to traditional bedding materials. Advantages to its use include the following:

Bedding

- Absorbs moisture
- Low bacteria
- Neutral pH
- Improved udder health

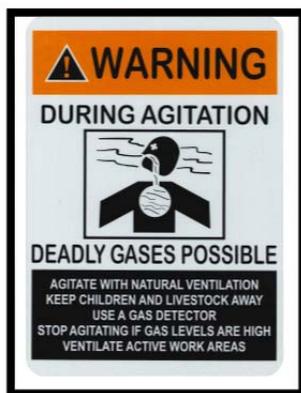
Soil

- Low carbon
- Adds sulfur
- Adds calcium
- Reduced phosphorus runoff



GYPSUM AND MANURE GAS HYDROGEN SULFIDE

Gypsum is calcium sulfate ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) so it provides a source of sulfate, which under anaerobic conditions can be microbially converted to hydrogen sulfide (H_2S) gas. Anaerobic conditions (without oxygen) exist in dairy manure slurry within many short-term and most long-term storages. Hydrogen sulfide is heavier-than-air. It therefore settles in low areas such as in pits, near storages, and in the breathing zones of calves and children. When present, H_2S is released in bursts that are dangerous to nearby humans and cattle during manure movement or agitation.



Hydrogen sulfide is immediately dangerous to life and health above 100 ppm. Lower concentrations of 10 to 20 ppm can be tolerated for periods of time, such as a part of a workday. Hydrogen sulfide gas has a familiar “rotten egg” odor to a healthy human nose. Unfortunately, this distinctive odor goes undetected at dangerous levels or after extensive exposure. Because of this, instruments are needed to detect H_2S concentrations to avoid dangerous conditions.

PERSONAL MONITORING TO SAVE LIVES

Portable gas instruments detect and indicate hazardous situations. Audible, vibration, and visual alarms are set to alert the user of dangerous gas concentrations that are not otherwise detectable. ***It is recommended that farm operators working around manure storages with gypsum bedding wear a hydrogen sulfide personal gas monitor.*** Single gas monitors (right) are about the size of a cell phone and cost under \$300. Units can provide multi-year battery life, display of gas level, and a second backup sensor. For professional dairy manure haulers a four-gas monitor offers additional safety from *methane*, low *oxygen* level in a confined space, *carbon monoxide* (exhaust) from equipment operation, in addition to *hydrogen sulfide* protection for gypsum-using farms.

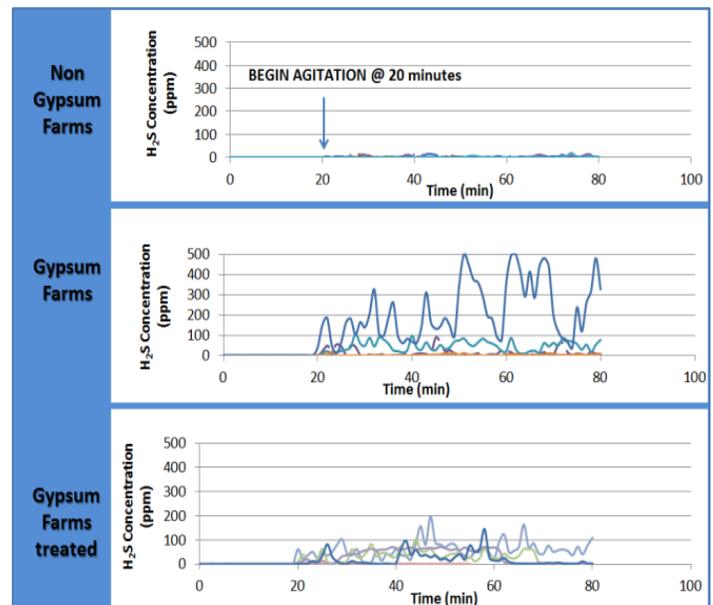


Photo Source:
Industrial Scientific

MONITORING MANURE AGITATION GAS RELEASE

Three types of farms were monitored based on their bedding management: 1) conventional dairy stall bedding; 2) gypsum bedding, and 3) gypsum bedding with a manure additive treatment. Instruments placed around the perimeter of the outdoor open-air manure storages recorded gas concentration immediately prior to and for up to two hours after manure agitation began. Findings are from ten farms during 19 events.

- The use of gypsum bedding increased H₂S gas release during manure agitation to levels that were dangerous near the storage (see graphs).
- Almost no H₂S was found near the non-gypsum dairy manure storages.
- Some additive-treated manure and crust-free manure reduced H₂S emissions during agitation.
- Operators with highest H₂S exposure were very close to agitation.
- The first 30 to 60 minutes of agitation is the most dangerous even near open-air outdoor manure storages.



REDUCING RISKS FROM GYPSUM-MANURE STORAGE

1. Gypsum bedding adds sulfur to manure that can lead to dangerous levels of hydrogen sulfide gas emission at agitation; but not all farms with gypsum bedding have safety problems.
2. Keep non-essential people away during agitation, especially children who are at increased risk as H₂S is typically at higher concentration close to the ground. Nearby cattle are also at risk.
3. Secure storage from entry; provide rescue and fall protection; gas monitors recommended.
4. Manure moving-mixing-agitation creates highest gas levels for the first hour. Leave the area.
5. Crust-free manure and additives seem to allow continuous H₂S release lowering agitation risk.
6. Gypsum benefits for cow bedding and agronomic values must be balanced against the potential gas hazard.

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