GYPSUM BEDDING
RISKS AND REWARDS

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GYPSUM BEDDING Introduction
Benefits and Use

What is gypsum and where does it come from

Uses in agriculture and benefits

Risk in manure storages – demonstration results

This presentation is archived at:
http://www.extension.org/pages/21819/chronological-webcast-archive
What is Gypsum

Calcium Sulfate
• CaSO₄·2H₂O (Hydrous)
• CaSO₄ (Anhydrous)

Naturally occurring mineral and coal plant byproduct

Manufacturing And Construction Waste

Gypsum is used to produce drywall for construction. Manufacturing rejects and construction waste is collected and recycled.

Manufacturing And Construction Waste Is Processed And Sold For Use In Agriculture

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Agricultural benefits – improves soil

- Improves soil structure (opens tight soils)
- Water is more mobile in soil
- Improves root development
- Improves soil nutrients
- Reduces phosphorus runoff
- Retains plant available nitrogen
- Provides source of secondary crop nutrients (Ca and S)

Agricultural benefits – ideal bedding for dairy cows

As bedding
- Moisture absorption
- Low bacteria counts
- Neutral pH

Gypsum bedding provides a sulfate source within the manure storage that reduces to form H₂S
Hydrogen Sulfide Creates A Dangerous Environment Heavier Than Air

<table>
<thead>
<tr>
<th>Exposure Limit</th>
<th>( \text{H}_2\text{S} \text{ Concentration (ppm)} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Permissible Exposure Limit (PEL) or Ceiling</td>
<td>20</td>
</tr>
<tr>
<td>Immediately Dangerous to life and Health (IDLH)</td>
<td>100</td>
</tr>
</tbody>
</table>

General Industry: 29 CFR 1910.1000 Table – Exposures shall not exceed 20 ppm (ceiling) with the following exception: if no other measurable exposure occurs during the 8-hour work shift, exposures may exceed 20 ppm, but not more than 50 ppm (peak), for a single time period up to 10 minutes.

Manure gases escape during agitation

Numerous reports of:
- REALLY strong smell
- Dead livestock
- Employees/workers overcome
- Some haulers would not haul from gypsum farms
March 2011 –
3 PA Workers Die In MD Manure Storage

Farm bedded with Gypsum

February 27, 2015
This presentation is archived at:
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Unresponsive but breathing 500-600 ppm H₂S

150 ppm H₂S

Barn 30 feet away-(30-60 ppm H₂S)

50 feet away (50 ppm H₂S)

Inside free stall (35 ppm)
METHODS: Three farm categories were observed in the fall and spring:

1. Gypsum
2. Gypsum with treatment
3. Non-gypsum

METHODS: H₂S concentrations were measured during agitation events using portable meters

METHODS: Temperature, wind speed and wind direction were recorded during data collection
METHODS: Manure was characterized

Field and Lab Analysis
- Samples were collected and analyzed for % solids, Ca, S, Total N, pH, ORP, PSC and temperature.

Physical Characteristics
- Crust thickness,
- Bottom sediments,

METHODS: Farm practices were documented

- Storage Design
  - Type of structure, volume

- Manure Handling
  - Loading, sulfate inputs

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Change in wind direction increased H$_2$S concentrations

Max H$_2$S concentration > 500 ppm

Max H$_2$S concentration > 64 ppm

Personal monitoring devices provide effective awareness of exposure

14 out of 18 operators did not exceed 20 ppm H$_2$S exposure
Best management practices lower exposure risk

4 out of 18 operators were exposed to H2S above 20 ppm

Operators with two highest H2S readings were close to agitation
Conclusions: H$_2$S Concentrations

- Increased gypsum application rate significantly increases cumulative H$_2$S concentrations.
- Treatments did not significantly reduce cumulative H$_2$S concentrations, but more research could show otherwise.
- Manure moving-mixing-agitation creates safety concerns related to high gas levels.
- Safety practice’s lower risk of exposure.
- Risk of exposure present even at 10 meters downwind from storages that contain gypsum.

Conclusions: Environmental Effects

- Wind speed and direction affect H$_2$S
- Temperature affected CH$_4$ but not H$_2$S.
Conclusions: Gypsum Benefits

Users and manufacturers claim gypsum retains plant available nitrogen – however measurements did not confirm this claim.

Phosphorus retention increases with increasing gypsum application rate, but not at bedding rates less than ½ lb gypsum per cow per day.

PSC=Phosphorus source coefficient

Additional Project Findings

Low concentrations of methane were observed at non-gypsum and gypsum farms during manure agitation.

Corrosion of metal fences and building components was observed at multiple farms that used gypsum.

Gypsum storages were reported by some users to have increased odors.

SUMMARY
On-Farm Demonstration Study

QUESTIONS?

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Practical Thoughts for Manure Handlers

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Confined Spaces

– Do not enter them!!
– Gases can cause loss of consciousness and death.
– Always assume there are gases present.

Open Air Manure Storage Safety

• Non-enclosed manure storages can still meet the definition of a confined space in terms of occupational safety and health:
  - Is large enough that a worker can enter and perform work;
  - Has limited or restricted means for entry or exit; and
  - Is not designed for continuous human occupancy

“Easy in. Hard to get out!”
What is your responsibility?

Everyone has an obligation to design, supply, buy, operate and maintain manure storage and handling systems that are safe for workers, visitors and children.

Gases

- Some are odorless
- Most (all) are colorless
- Some are explosive
- Some sink (e.g. H₂S)
- Some rise

H₂S

- Many people can detect it <1 ppm
- Can deaden sense of smell at 100 ppm
- Deadly 600 ppm
**Invest in the Insurance of a Monitor**

Test atmosphere
- Oxygen deficiency
- Combustibles
- Toxic gases

Multiple gas vs single gas—cost and ease of use will be a factor

Most reliable way of "seeing" the invisible

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**Open Air Manure Storage Safety**

Safety tips include:
- No horseplay
- No smoking, open flames or sparks
- If equipment malfunctions shut it off and remove it before servicing.
- If feeling unsure or uncomfortable, step back, contact someone and review the situation before proceeding.
- Be prepared to call 911 if an emergency happens.
  - Accurately describing the incident, number of victims, and giving specific directions to the site of the emergency.

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**Tips for Operators**

- Use a monitor.
- Observe agitation from a distance. Consider remote control kill switches.
- The first hour of agitation is probably the worst, but *never* let your guard down.
- H2S is a heavy gas—higher is better.
- Remember health of nearby livestock.
- This is one time when the Agricultural Work Ethic can backfire!
**Observed gas behavior**

Gases ‘throw’ in the direction of manure agitator nozzle, so be aware of dangerous impact on ‘downwind’ animal- or human-occupied areas.

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**Operator Position – up and away**

Position operator work area so that a person...
- Does **not** reach over the storage for routine practices
- Does **not** work or need to adjust machinery near storage edge
- Is **not** in a low-lying area. (Remember H₂S is a heavy, ground-hugging gas)

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**Gypsum bedding should not be used with under-barn manure storage**

Unconditional recommendation **against** under-barn manure storage when gypsum bedding is used.
New NRCS Warning Sign

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Gypsum and Liquid not needed

- All manures are organic material in a state of microbial degradation.
- Gases are a by-product of microbial respiration.

Body Alarms!!!

- Dizziness
- Wobbly knees
- Feeling hot and clammy
- Lack of attention to details
- Loss of motor skills/ fatigue
- Anxiety
- Severe eye irritation/ decrease in sight
- Irregular/fast heartbeat

Pay attention to your body. Take action if there are signs of gas exposure. Get to fresh air!
Learn More at the North American Manure Expo

- Data collection demonstrations (July 14 Tour Day)
- Highlighted education on manure gas issues

Chambersburg, PA
- Tour Day - July 14
- Main Event - July 15

manureexpo.org

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Manure Gas Risks Associated with Gypsum Bedding at Dairy Farms

Penn State Investigators
- Eileen Fabian-Wheeler, Mike Hile, Davis Hill, Dennis Murphy, Robin Brandt, Hershel Elliot, Mike Platek, Robert Meinen

Acknowledgment and Thank You to the supporters of this project.

www.manurepitsafety.psu.edu

Video Presentations:
- Reducing Entry Risk: Solid Floor Storages
- Reducing Entry Risk: Slotted Floor Storages

Fact Sheets:
- E 51: Confined Space Manure Storage Hazards
- E 52: Confined Space Manure Gas Monitoring
- E 53: Confined Space Manure Storage Ventilation System Design
- E 54: Confined Space Manure Storage Emergencies
- Open Air Manure Storage Safety Tips

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More information on issues surrounding handling manure with gypsum bedding

- Agricultural Safety website
  - extension.psu.edu/business/ag-safety
- Gypsum bedding and manure handling
  - abe.psu.edu/news/2014/gypsum-bedding...is-it-worth-the-risk
- Commercial Manure Hauler and Broker Certification Program
  - www.agriculture.state.pa.us
- North American Manure Expo
  - manureexpo.org

Thank you!

Come see us at Waste to Worth

- Mike Hile will present this information at the Poster Session

QUESTIONS?