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

What is Gypsum

Calcium Sulfate
• CaSO$_4$·2H$_2$O (Hydrous)
• CaSO$_4$ (Anhydrous)

Naturally occurring mineral and coal plant byproduct

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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

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>H₂S 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 E: 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

Child Found Unresponsive Here (2011)

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May 2012 – 3 PA Workers Die In MD Manure Storage

Farm bedded with Gypsum

Dairy Farmer’s Boys Have Close Call With Manure Gas

Unresponsive but breathing 500-600 ppm H₂S

150 ppm H₂S
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,

ORP=oxidation reduction potential
PSC=Phosphorus source coefficient

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**METHODS:** Farm practices were documented

- **Storage Design**
  - Type of structure, volume

- **Manure Handling**
  - Loading, sulfate inputs

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**Non-gypsum farms**

**Gypsum Farms**

**Gypsum farms treated**

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**Change in wind direction increased H₂S concentrations**

Max H₂S concentration > 500 ppm

Max H₂S concentration > 64 ppm

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Personal monitoring devices provide effective awareness of exposure

14 out of 18 operators did not exceed 20 ppm H₂S exposure

Best management practices lower exposure risk

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

Operators with two highest H₂S readings were close to agitation

Concentrations 10 meters away from storages were measured

Elevated H₂S concentrations were observed at farms that use gypsum

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Conclusions: H₂S Concentrations

- Increased gypsum application rate significantly increases cumulative H₂S concentrations.
- Treatments did not significantly reduce cumulative H₂S 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 H₂S
- Temperature affected CH₄ but not H₂S.

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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