Managing Swine Deep Pits: Understanding and Managing Foaming and Hydrogen Sulfide

Daniel Andersen
Learning Objectives

• Manure Foam
  – Definition and background
• Dangers of foam
• Current research on foaming

• Hydrogen Sulfide Issues
Manure Foam

• Viscous
• Dark brown to grey
• Solids-rich liquid
• With entrained bubbles of gas
Manure Foam

• Mass of bubbles of gas on surface of a liquid

• Thick, mucous like consistency
Manure Foam
Manure Foam Continued

• Spontaneously formed on manure surface during storage
  – Long-term stability, contains methane

• NOT caused by agitation or aluminum/iron chloride addition
  – Entrain bubbles but only short term stability
  – Contains air or carbon dioxide
Foam and the Environment

• Pit Storage Reduction
  – Stressed Pumping Cycle
  – Untimely Manure Application

• Safety Considerations
  – Fires
  – Gasses
Foam and the Environment

• Nuisance Issues
  – Cleanliness of animals
  – Less manure fits in a tank wagon
Dangers of Foam and Methane

• Methane produced during anaerobic breakdown of manure

• Methane captured in foam
  – Foam gases 60-70% methane
  – Serves a fuel source for fires

• Breaking foam releases methane and can cause dilution with barn air to explosive levels
Dangers of Foam and Methane

Brown – Manure
Red – Methane at High Concentration
Yellow – Methane at Flammable Concentrations
White – Barn Air

Foam breaks causing large release of methane
Dangers of Foam and Methane
Dangers of Foam and Methane
Dangers of Foam and Methane
I have foam, what should I do

• Use caution, foam is dangerous
• Monitor your pit and foam level
• When to act
  – More than 6” present
  – Less than 24” to slatted floor
I have foam, what should I do

- Remove some manure to increase headspace
- Sprinkle with water (use caution)
- Add anti-foaming agents
- Microbial Control
  - pH shift, oxygen, anti-microbial
- Eliminate sources of sparks
  - Cigarettes, sparking switches or motors
  - Welding and grinding
A Note on Manure Additives

• There are a lot of products available
• **FEW** have been tested

• Monensin/Narasin
Monensin/Narasin

Cumulative Methane Production (Percent of Control)

Days of Incubation

Control

0.75 mg/kg

1.5 mg/kg

3.0 mg/kg
Precaution if treating foam

- Attempting to break foam will release explosive levels of methane. Therefore:

1. All ignition sources OFF (pilot lights, welding, etc.)
2. Ventilate at a minimum of 30 cfm/pig space
3. Vacate barn
4. Treat foam/pit
Ventilation Dilution Time

Graph showing the relationship between ventilation time and methane concentration. Key points:
- 2 min at 90,000 cfm
- 3 min at 60,000 cfm
- 6 min at 30,000 cfm

Legend:
- V=30,000 cfm
- V=60,000 cfm
- V=90,000 cfm

Note: Trapped methane in foam measured at 70% or more.
In case of a flash fire

• Do NOT enter the facility
• Do Not spray water into pit if foam is present
• Call Emergency Personnel
  – Owner
  – Fire department, etc.
Hydrogen Sulfide

- Produced by anaerobic decomposition
- Released in high quantities during agitation
- ~40 deaths in Midwest since 19080
Hydrogen Sulfide

- Never allow any person inside burn during slurry pumpout
- Highest concentrations in areas near agitation or areas of poor ventilation
- Avoid directing jet agitation towards pumpouts
Ventilation Tips

• Open inlets to reduce static pressure
• Use a tarp to seal around the manure pump and agitation return
• Maximize ventilation
• Remove 1-2 ft manure before starting agitation
Changing Gears

• What are we doing about foam?
• Current research on causes and prevention of manure foam
Iowa Pork Producers Project

• Goal: Find and correct the root cause of foaming
• Multi-state project (Iowa, Illinois, Minnesota)
• Professionals with expertise in manure management, chemistry, microbiology, feed rations and digestibility
• Project managed by Steve Hoff at Iowa State
• Team is working diligently to solve the problem
Multi-State Collaboration

**ISU Analysis**
- Methane production
- Foaming potential testing
- Surface Tension, Viscosity, Particle Size and Density
- Short and Long Chain Fatty Acid

**UMN Analysis**
- Extensive producer survey
- Microbial analysis
- Foaming potential testing

**UIUC Analysis**
- Organize all manure sampling and distribution
- Microbial Community Analysis
- On-Farm Factor Correlation
Iowa State University

- Physical and Chemical Analysis
  - Methane Production Rates
  - Short and Long Chain Fatty Acids
  - Surface Tension
  - Viscosity and Density
  - Foaming capacity and stability
Iowa State University

• Diet and Feeding Trials relation to foaming

<table>
<thead>
<tr>
<th>Protein Study</th>
<th>CP %</th>
<th>Carbohydrate Study</th>
<th>NDF%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn with Amino Acids</td>
<td>C/AA</td>
<td>Corn-Soybean Meal</td>
<td>8.7</td>
</tr>
<tr>
<td>Corn-Soybean Meal with Amino Acids</td>
<td>C-SBM/AA</td>
<td>Barley</td>
<td>14.8</td>
</tr>
<tr>
<td>Corn-Soybean Meal</td>
<td>C-SBM</td>
<td>Beat Pulp</td>
<td>17.6</td>
</tr>
<tr>
<td>Corn-Canola Meal</td>
<td>C-CM</td>
<td>Distillers Dried Grains with Solubles</td>
<td>17.6</td>
</tr>
<tr>
<td>Corn-Corn Gluten Meal</td>
<td>C-CGM</td>
<td>Soy Hulls</td>
<td>17.6</td>
</tr>
<tr>
<td>Corn-Poultry Meal</td>
<td>C-PM</td>
<td>Wheat Bran</td>
<td>17.6</td>
</tr>
</tbody>
</table>
University of Minnesota

Develop and on farm foaming index to identify high risk barns

Survey producers to determine extend and commonalities between foaming facilities
University of Illinois

• Microbial Community Analysis
  – Microbe Census

• Develop a Farm Factor Database
  – Environment and Management factors to correlate with foaming
Preliminary Results

- 60+ sites sampled
- 100+ barns samples
- Multiple integrators
- Samples collected monthly from multiple manure levels
Methane Production

• Barns with foam consistently have higher methane production

• Not only does foam capture methane, there is more methane
Foam Formation and Stabilization

- Surface active agent at manure surface stabilize bubbles and foam
Foam Formation and Stabilization – Surface Tension and Long Chain Fatty Acid
University of Illinois – Sample Analysis

1. Manure microbial communities are collected

2. DNA is extracted for microbial census

3. DNA “fingerprints” to characterize manure microbial communities

4. Analyses to compare similarity of manure microbial communities among foaming and non-foaming sites. Each point represents a microbial community sample, dissimilarity is represented as distance. Clusters of points reveal differences in microbial assemblages among foaming and non-foaming deep pits.
University of Illinois – Sample Analysis

• Interpretation – Two points close together had similar microbe populations, far apart were different
Database Analysis

- Foaming correlated most strongly with methane production, temperature, and depth. Some correlation with fiber and DDGS in ration.
Summary

• Foaming is a serious concern and safety hazard
• Use caution with disturbing foam, such as when pumping manure.
• Research underway on determining the cause of manure foaming – We are making progress
Questions and Comments

Daniel Andersen
Iowa State University
dsa@iastate.edu
515-294-4210