3rd Annual
Anaerobic Digester Foaming Workshop
February 8, 2012

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Outline

- Foaming Survey Drivers
- AD Foaming Committee Survey Goals
- Summary of 2010/2011 Survey Questionnaire
- Survey Results
- Discussion
- Recommendations
- Questions
Survey Drivers

- Inefficient Gas Recovery
- Inverse solids profile
- Blockage of gas mixing devices
- Foam binding of recirculation pumps
- Fouling of gas collection pipes – boilers/engine operation
- Foam accumulation between covers and walls
- Cover tipping
- Energy, Economic, Manpower

Source: Wastewater Bacteria, Michael Gerardi
Goals - Identify Relationships

- Type of Anaerobic Digesters
- WAS Thickening - Polymers
- Type of AD Mixers
- pH, Tem, Alkalinity
- Feed Sludge
- Filaments
- Nutrient Removal
- Liquid Stream Treatment
- Liquid Stream Foaming
Characteristics of Anaerobic Digesters (AD)
- Type of Reactor
- Detention Times
- Type of Mixers

Anaerobic Digester Foaming Issues
- Causes and Remedies

Characteristics of Liquid Biological Treatment Process
- Treatment Requirements and Processes (NH3? TN? TP?)
- Occurrence of Foaming?
2011 Survey Questionnaire – Attempted to Dig Deeper

- Same questions as 2010
- Mixing times, sequence, etc.
- Heating equipment and methods
- Feed sludge type, blending, etc.
- Feeding times, sequence, etc.
- Hauled waste acceptance
- Volatile Solids loading rates
- Temperature, pH, Alkalinity…
### Survey Response

<table>
<thead>
<tr>
<th>State</th>
<th>WWTP operating AD’s</th>
<th>2010 Survey Response</th>
<th>2011 Survey Response</th>
<th>(% of Total)</th>
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<tbody>
<tr>
<td>Illinois</td>
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<tr>
<td>Minnesota</td>
<td>56</td>
<td>94</td>
<td>42</td>
<td>(44%)</td>
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<td>Wisconsin</td>
<td>96</td>
<td>(44%)</td>
<td>(19%)</td>
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<tr>
<td>Total</td>
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Survey Results
Significant Digester Foaming in last 10 years?

2010 Survey - 94 Responses

- Yes: 53% (50 of 94 Responses)
- No: 47%

2011 Survey - 41 Responses

- Yes: 62% (26 of 41 Responses)
- No: 38% (14 of 41 Responses)
Size of WWTPs and AD Foaming

2010 Survey - 94 Responses

2011 Survey - 41 Responses

Percent of Plants w/ Digester Foaming

< 1.0 mgd 1 to 5 mgd 5 to 20 mgd > 20 mgd

2010 Survey:
- 6 of 19: 32%
- 27 of 45: 60%
- 12 of 24: 50%
- 6 of 7: 86%

2011 Survey:
- 2 of 5: 40%
- 5 of 16: 31%
- 3 of 10: 33%
- 5 of 11: 45%

< 0.5 mgd 0.5 to 2 mgd 2 to 5 mgd > 5 mgd
### Type of Anaerobic Digester and AD Foaming - 2010

**Out of 50 Plants**

- **Percent of Plants Responded**
  - Meso Only: 56%
  - Thermo Only: 43%
  - TPAD: 6%
  - Acid-Gas: 0%

- **Percent of Plants w/ Digester Foaming**
  - Meso Only: 94%
  - TPAD: 6%

- **46 of 82**
  - Meso Only
  - 0 of 1
  - 3 of 7
  - 0 of 3

**Legend**
- Meso Only
- Thermo Only
- TPAD
- Acid-Gas
Digester Detention Time and AD Foaming - 2010

Percent of Plants w/ Digester Foaming

- 1 - 10 days: 60% (3 of 5)
- 11 - 20 days: 61% (14 of 23)
- 21 - 30 days: 47% (16 of 34)
- > 30 days: 59% (19 of 32)
Biological Treatment and AD Foaming

2010 Survey - 94 Responses

- Activated Sludge: 43 of 73 (59%)
- Trickling Filters: 10 of 25 (40%)
- RBCs: 3 of 10 (30%)

2011 Survey - 41 Responses

- Activated Sludge: 14 of 31 (45%)
- Trickling Filter: 0 of 10
- RBC: 0 of 4

Percent of Plants w/ Digester Foaming

43 of 73

Foaming in Activated Sludge
Activated Sludge Plant/AD Mixers - Foaming

43 Plants

Percent of Activated Sludge Plants w/Digester Foaming

- Gas - Canon: 14%
- Gas - Lances: 29%
- Liquid - Pumped Recirc: 35%
- Liquid - Draft Tube: 15%

14 out of 43

Foaming in Activated Sludge Plants

- Gas - Canon: 11%
- Gas - Lances: 32%
- Liquid - Pumped Recirc: 50%
- Liquid - Draft Tube: 14%
Nitrogen Removal and AD Foaming

2010 Survey - 94 Responses

- NH3 Removal: 60%
- Total N Removal: 50%
- No N Removal: 9 of 24

41 of 68

2011 Survey - 41 Responses

- NH3 Removal: 40%
- No NH3 Limit: 27%

12 of 30

Percent of Plants w/ Digester Foaming
Nitrogen Removal and AD Foaming

2010 Survey – 50 Plants with AD Foaming

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%

NH3 Removal
Total N Removal
No N Removal

82%
4%
18%

2011 Survey - 41 Responses

100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%

NH3 Removal
No NH3 Limit

12 of 30
3 of 11

40%
27%

NH3 Removal
No N Removal
Blending PS/WAS – AD Foaming 2011

- Prior Blending
- No Prior Blending

Percent of Plants with Digester Foaming

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Trucked Waste and AD Foaming - 2011

- 7 of 14 plants with digester foaming
- 3 of 14 plants with FOG foaming
Other Factors – AD Foaming 2011

- pH varied anywhere between 7 and 7.5
- Hot water sludge recirculation in all instances of AD Foaming
- 1.5% to 3% TS in the feed
- 50% to 70% TVS in the feed
- Average Temperature @ 95°F (35°C)
- Mixing Operation
Survey Comments - Addressing AD Foaming

- Cease recirculation, water spray when applicable, shovel frozen material

- Maintain low digesters temps (85-95)

- Rotate feeding/heating/recirculation between 4 digesters very frequently

- Reduce gas pressure (from 6.7 to 6.0 in WC)

- Intermittent mixing

- Bypassing 20-40% of the WAS around the digesters and going directly to winter biosolids storage for long term digestion
  - WAS STABILIZATION / MINIMIZATION

- Trying a new feed scheme: separate digestion of WAS and primary sludge

- Trialing defoamant chemicals
Survey Comments to Addressing AD Foaming

- Pump to storage; turn off mixing

- Major foaming after we put the new activated sludge plant on line. We tried many approaches for the first 5 years in vain. We finally stopped pumping grease into the digester and since then we have had no foaming issues for about 2 years now
  - COFERMENTATION

- Spray down the covers and keep a lower sludge level in tanks.

- Gas mixing Perth units contribute to foaming issues, units are turned off most of day.
- Primary scum is not pumped to digester, hauled off site.
- Reduce sludge age to keep filamentous growth minimal

- Reduced the pump mixers frequency and duration
Survey Comments to Addressing AD Foaming

- It's rarely a serious problem. Usually mixing and heating along with feed rate reduction will correct the problem in a few days or so.

- If foaming gets excessive, we generally first turn off gas mixing and hose down foam.

- Stopped pumping from Grease Pits
  - COFERMENTATION
OK...Then...

- Who is/are the Culprit(s)?
  - Foam initiation
  - Microbial/Biochemical?
  - Chemical?

- Who is the Accomplice?
  - Foam Stabilization
  - Microbial/Biochemical?
  - Chemical?
What can we interpret?

- **Activated Sludge Foaming & WAS**
  - Effect of Liquid Treatment Systems

- **Operational Parameters**
  - Gas mixing
  - Heating System & Temperature Fluctuations
  - Loading Rate
  - pH, Alkalinity...

- **MORE could potentially create favorable conditions for foam initiation and stabilization**
General Housekeeping

- Avoid Temperature Fluctuation
  - Optimize heating systems
- Sufficient but not excessive mixing
- Avoid fluctuations and excessive loading rates
  - Threshold dependent on feed/digested sludge
- Avoid foaming in liquid treatment processes
- Understand YOUR Digester
  - Data Collection
Recommendations

- Remove Froth from Activated Sludge Tanks
  ASAP
  - No Huge Slug waiting to be sent

- Minimizing/Mitigate Frothing Filaments
  - Defoamants

- Grease is not always bad
  - Energy Value
  - CoFermentation
Recommendations (contd.)

- Enhancing Filament Destruction in WAS
  - Sludge/WAS Minimization
  - WERF’s 05-CTS-3 Evaluation of Processes to Reduce Activated Sludge Solids Generation and Disposal
    - Thermal Hydrolysis
    - Ultrasound
    - Microsludge
    - Paused Electric Field
Co-Fermentation Strass WWTP, Austria (WERF)

The chart shows the production, consumption, and self-sufficiency of energy consumption at Co-Fermentation Strass WWTP, Austria (WERF) from August 2003 to November 2009. The energy consumption is measured in Wh/PE (Watt-hours per person equivalent). The chart indicates fluctuations in production and consumption, with a notable increase in self-sufficiency in the later years.
Ultrasound Sludge Disintegration – Meldorf WWTP Germany

- 4 mgd Plant
- TWAS
- CoFermenatation
- Mesophilic
- Bio-P
- TN Removal
- Microthrix
- Payback in 3 years

Source: www.ultrawaves.de
Mechanical/US Disintegration

Fig. 5. Gas production after 14 days digestion of samples of activated sludge with and without addition of a part of disintegrated activated sludge or foam

Source: A. Machnicka