CSWEA Anaerobic Digester Foaming Workshop 2010

Anaerobic Digester Foaming – Past, Present, and Future

April 21, 2010
Madison, WI

Speaker: Krishna Pagilla
Presentation Outline

• Foaming Causes Summary
• Past Research Results from SRWTP and Pilot Scale Work
• Recent Efforts – MWRDGC and UdG, Spain Modeling Efforts
• Future Plans – NYCDEP, MWRDGC, Hazen and Sawyer, and IIT Joint Effort
• Questions and Comments
Digester Foaming Causes

**FEED SLUDGE CHARACTERISTICS**

- **Surface active agents**
  - Proteins
  - Detergents
  - (Khan and Forster, 1990)
  - (Gonzales et al., 2003)

- **Organic loading rate**
  - (Pagilla et al., 1997)
  - (Barjenbruch et al., 2000)
  - (Brown, 2002)
  - (Svensson et al., 2002)
  - (Moen, 2003)
  - (Barber, 2005)
  - (Murto et al., 2005)
  - (Massart et al., 2006)
  - (Schafer et al., 2006)

- **Filamentous bacteria**
  - Gordonia spp. and M. parvicella
  - (Pagilla et al., 1997)
  - (Westlund et al., 1998)
  - (Eikelboom, 2000)
  - (Moen, 2003)
  - (Barber, 2005)

**ANAEROBIC DIGESTER**

- **Design characteristics**
  - Mixing
    - (Pagilla et al., 1997; Barber, 2005; Moen, 2003)
  - Shape

- **Operational conditions**
  - VFA
    - (Pagilla et al., 1997; Westlund et al., 1998; Barjenbruch et al., 2000)

  - Temperature

Dalmau et al., 2010; Bioresource Technology
Specific Gravity

Mech. Mixing
Gas Mixing

Surface Depth, m

Total Solids, %

SRT = ~ 16 days; VSLR = ~ 2.2 kg/m³.day

Pagilla et al., 1997; Water Sci. Technology
Digester Foaming Effects

- The foaming due to *Gordonia* (*Nocardia*) *amarae* in the feed sludge

- Surface foam layer ranged from 1.3 m in mech-mixed digester to 2.4 m in gas-mixed digester

- Solids profile inversion in both digesters, 5% to 2% TS (Feed Sludge = 3.4% TS)

- Average gas production was 0.93 m$^3$/kg VS destroyed in mech-mixed digester to about 0.74 m$^3$/kg VS destroyed in gas-mixed digester

- VS reduction in mech-mixed digester about 54% compared to 62% in gas-mixed digester
Nocardia Filament Counts in Sludge
Chlorination of Foaming WAS

Low Chlorine Dose
20-60 mg/L of WAS

High Chlorine Dose
100-200 mg/L of WAS

Pagilla et al., 1998; Water Sci. Technology
Foaming in Anaerobic Digestion (FAD Risk)
Effect of Organic Loading Rate (OLR)

Dalmau et al, 2010; Bioresource Technology
Foaming Problem at MWRDGC’s Calumet WRP

- Not new to CWRP but mostly benign and to acceptable level
- For last two years, frequent and persistent foaming episodes
- Dec 2009 through Jan 2010
- March 2010 till to date

Foam Potential

<table>
<thead>
<tr>
<th>Cumulative time, min</th>
<th>Feed</th>
<th>Draw</th>
<th>Foam from ~14' depth through thief hole</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foaming Potential, %</td>
<td>0.02</td>
<td>19.60</td>
<td>500</td>
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<tr>
<td>Foaming stability Index</td>
<td>n/d</td>
<td>n/d</td>
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</table>

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## CWRP Lab Results

<table>
<thead>
<tr>
<th></th>
<th>FOG mg/L</th>
<th>MBAS mg/L</th>
<th>pH SU</th>
<th>Temp °C</th>
<th>TSW %</th>
<th>VTSW %</th>
<th>SP_GRAV @ 4°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digester Feed</td>
<td>&lt;167.000</td>
<td>5.76</td>
<td>16.8</td>
<td>4.21</td>
<td>69.24</td>
<td>0.998</td>
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<tr>
<td>Digester 1 Draw Grab</td>
<td>&lt;125.000</td>
<td>7.34</td>
<td>31.7</td>
<td>2.68</td>
<td>60.55</td>
<td>0.985</td>
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<tr>
<td>Digester 1 Roof Top Foam</td>
<td>-</td>
<td>7.22</td>
<td>24.6</td>
<td>3.80</td>
<td>67.84</td>
<td>0.450</td>
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<tr>
<td>Digester 1 Foam Grab from 14' depth</td>
<td>-</td>
<td>-</td>
<td>7.62</td>
<td>25.4</td>
<td>63.26</td>
<td>1.012</td>
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</tbody>
</table>

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Current and Future Efforts

**Project Subcommittee**

**Technical Advisory Committee**
Dr. David Jenkins, Dr. David Stensel, & Dr. Andre van Niekerk

**Universities**
- Illinois Institute of Technology, Chicago, Dr. Krishna Pagilla, P.E.
- UC Berkeley, CA, Dr. Slav Hermanowicz
- Manhattan College, NY, Dr. Robert Sharp

**Municipal Utilities**
- MWRD, Chicago, IL
- San Francisco, CA
- City of Elmhurst, IL
- New York City DEP

**Companies**
- Hazen & Sawyer
- OpenCEL
Questions
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Some Possible Solutions –

• Improved and steady feeding rates
• Short term polymer or defoamer addition (PAX)
• Activated sludge foaming control
• Scum or foam hydrolysis and stabilization (e.g., OpenCEL)
• Sufficient gas collection piping capacity to meet peak gas production rates
• MOST IMPORTANT – A large scale study to find universal understanding of the problem causes, effects and solutions.