Are your Digesters Burping, Frothing, or otherwise not Behaving?

October 27, 2017
Presentation Outline

• Is digesting sludge specific gravity of one?
• What are the process implications?
• Are there design modifications that can help reduce the impact?
What is going on inside anaerobic digesters?

• Digesters are biologically complex, relying on a series of different microbial communities to reduce sludge mass.

• Not readily observable like open clarifiers or aeration basins
  • View ports
  • Cameras – DCWater has a new camera system inside the digesters

• This means that we typically make assumptions about the environment within the digester.
  • Completely mixed
  • Digested sludge specific gravity is close to 1
Why might we think that SG = 1 is not correct?

• Digesters produce significant amounts of digester gas as they convert raw sludge to biomass.

• Research on volume expansion has shown that at different viscosities the extent of gas hold up in the sludge changes
  • Higher viscosity more gas hold up, lower the intensity of mixing the lower the overall viscosity of the sludge.
  • Mixing helps convey gas out of the sludge.
What may be going on in your digesters
### OWASA (Chapel Hill, NC) Measurements

<table>
<thead>
<tr>
<th></th>
<th>1st Stage</th>
<th>2nd Stage</th>
<th>3rd Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pressure (ft WC)</strong></td>
<td>22.6</td>
<td>19.3</td>
<td>15.8</td>
</tr>
<tr>
<td><strong>Radar Surface (ft WC)</strong></td>
<td>30.4</td>
<td>23.3</td>
<td>19.0</td>
</tr>
<tr>
<td><strong>Difference (ft)</strong></td>
<td>7.8</td>
<td>4.0</td>
<td>3.2</td>
</tr>
<tr>
<td><strong>Ave. Specific Gravity</strong></td>
<td>74.5%</td>
<td>82.6%</td>
<td>83.2%</td>
</tr>
</tbody>
</table>
Tallman Island digester wall temperature profile

Would expect wall temperature to be fairly uniform if completely mixed and uniform temperature inside
Why do we care?

• Process implications
  • HRT ≠ MCRT
  • Mass in the system divided by mass wasted
  • Biosolids regulations written around MCRT
  • Could you see deteriorated performance
  • Organic loading can be higher than expected

• Operations and facilities impacts
  • Surcharging of digester cover
  • Tank overflows

Brown and Caldwell
Theoretical analysis of SG impacts on digester process metrics

Reality is likely a stratified system

Simplified Model Used
Heavily loaded digester example

Theoretical MCRT = 15 days
Theoretical OLR = 0.16 lb-VS/ft^3-day

OWASA SG Range
A detectable reduction in VSr may be difficult to see on a daily basis.
Potential process impacts summarized

- Reduced active volume can result in overloading at apparent loadings below stated design conditions.
  - Especially if stratified and upper portion of the tank is not available.

- Reduced residence time can result in a reduction in VSr resulting in increased biosolids production.

- Reduced residence time could impact biosolids stability (odors)
How do we get low-specific-gravity digesting sludge in our digesters
The idea revisited...
A design common to many digesters suggests we did not consider reduced SG.
Just to Note: This is Clearly NOT to Scale...
Our draw off should look more like this
What does this cause???

• The level in digesters is almost always higher.
What does this cause???

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- Overflow “boxes” force the actual level higher.
What does this cause???

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- Higher levels create foaming episodes.
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What does this cause???

Ultimately:
This can cause
Cover Failures
Tallman Island Trapping Low-SG Sludge in Upper Layers
Tallman Island Trapping Low-SG Sludge in Upper Layers

7.5” WC Gas Pressure

PHOTO #3
Hunts Point Wasting Configuration Similarly creates Low-SG Sludge Trap
Hunts Point Wasting Configuration Similarly creates Low-SG Sludge Trap
This doesn’t just happen in NYC:

Nashville, TN
This doesn’t just happen in NYC: Nashville, TN
Potential Solutions
Tallman Island

7.5” WC Gas Pressure
Tallman Island Concept was Steel Plate
Hunts Point
Hunts Point concept is a pipe and valve.
Nashville
Nashville’s Initial Contractor Fixes

- Foam-Busting Surface Nozzle
- Emergency “Hatch”
- Radar Level Element
Nashville’s Current Improvements
Planned implementation for surface wasting at Nashville
For some Tanks, the “Fix” is **FREE**
For some Tanks, the “Fix” is **FREE**
Solution at Owls Head
Owls Head Conversion Performance

Cautioned that **surface wasting was NOT** the only digester enhancement
Owls Head Conversion Performance
Conclusions
Conclusions

Our assumptions around sludge specific gravity in an anaerobic digester may not be correct

• Consider whether this explains some problems/experiences...

• Consider what it means for your next project (upgrade or new digesters)...

QUESTIONS?

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