DIGESTER FOAMING CAUSES AND SOLUTIONS

CWEA Math, Operations, and Maintenance for Biosolids Systems Seminar

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LEARNING OBJECTIVES

Causes
• Process control
• Operational
• Process – digester internal

Control methods
• Process control
• Operational awareness
• Process monitoring

Physical improvements
• Installed improvements
PERSONAL EXPERIENCE

$3M catastrophic failure of digester roof
$1M repair of “fixed” holding tank roof

Saved two other digesters from roof failures
Ruined one pair of beige Dockers
WHAT CAUSED FAILURE

• Over-wasted secondary
  – Filaments
  – Much more volume compared to primary

• Gas mixing system piping approach

• Plugged flame arrestors – from foam

• Level indicator wrong
  – From foam entrained in contents

• Didn’t shut off mixer soon enough

• After first failure, reduced active volume created organic overload of other units in service (i/s)
CAUSES
PROCESS CONTROL CAUSES

• The blend of primary sludge to secondary sludge
  – The more primary sludge, the better
  – Measured as pound to pound, not gallon to gallon

• Excessive filaments in the secondary sludge
  – *Nocardia* and *microthrix parvicella* add bulk and structure to foam

• Feed fluctuations
  – Both solids loading and volume
OPERATIONAL CAUSES

• Inadequate or inconsistent mixing
  – Rapid changes create unpredictable results
  – Gas binding of pump used to mixing

• Excessive and/or fine bubble mixing
  – Can change the specific gravity and “fluff” the contents

• Rapid change in internal pressure
  – Cogeneration demands
  – Moisture in gas handling system
OPERATIONAL CAUSES

• Insufficient volume
  – Liquid level too low
  – Processing volume taken up by grit or scum “raft”
  – Units out of service for maintenance or construction
  – Results in solids loading rates greater than design

• Temperature fluctuations
  – Created by heating or feed disruptions

• Rapid change in liquid level
INTERNAL CAUSES

• Microorganisms competing for food
  – Acid formers vs. methane (alkalinity) formers

• Surfactants
  – Oil and grease
  – Overdosed polymer in thickening or dewatering processes

There are usually multiple contributors
POTENTIAL CONTROL METHODS
PROCESS CONTROL

• Primary sludge and secondary sludge ratio
  – Maximize primary solids removal efficiency
  – Maximize primary BOD removal efficiency

• Filaments in the wasted secondary sludge
  – Review operating conditions and take corrective action

• Feed fluctuations
  – Ideal is constant feed of comparable volume to all digesters in service
OPERATIONAL CAUSES

• Insufficient volume
  – Confirm liquid level
  – Confirm active volume
  – Understand seasonal trends of sludge production

• Rapid change in liquid level
  – Strive for consistent dewatering feed rates
  – Check valving, especially after maintenance work
  – Be suspicious of the level indicators
OPERATIONAL CAUSES

• Inadequate or inconsistent mixing
  – Avoid on/off control
  – If problem is recirculation pump gas binding, change type
  – Review directional mixing approach

• Excessive or fine bubble mixing
  – Adjust equipment

• Rapid change in internal pressure
  – Strive for consistent feed
  – Drain moisture traps
INTERNAL CAUSES

• Temperature fluctuations
  – No more than 1 degree F per 24 hour change – up or down

• Avoid septic sludge
  – More acidic than fresh sludge so greater reaction with alkalinity

• Surfactants
  – Review scum and FOG feed rates
  – Avoid polymer overdose

OBSERVE SYMPTOMS; FIND CAUSES
OPERATIONAL AWARENESS

Placing a digester in service

- Ramp the feed up slowly
- Avoid seeding with poor quality sludge
- Ramp up mixing system slowly
- Maintain heat throughout
OPERATIONAL AWARENESS

Taking a digester out of service

• Ramp down the mixing system slowly

• Lower liquid level slowly as this sludge is usually transferred to other units in service
OPERATIONAL AWARENESS

Feed strategies

• Ideal is constant loading to each unit in service
• Minimize downtime between feeding

Withdrawal strategies

• Consistent rate from all units in service

Feed disruptions

• Plan maintenance and construction activities
### PROCESS MEASUREMENT

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Measurement</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed volume</td>
<td>gallons per feed cycle</td>
<td>Equal to all units i/s</td>
</tr>
<tr>
<td>Feed volume</td>
<td>gallons per day</td>
<td>Equal to all units i/s</td>
</tr>
<tr>
<td>Feed solids</td>
<td>pounds per feed cycle</td>
<td>Equal to all units i/s</td>
</tr>
<tr>
<td>Feed solids</td>
<td>pounds per day</td>
<td>Equal to all units i/s</td>
</tr>
<tr>
<td>Primary solids to secondary solids</td>
<td>pounds / pounds</td>
<td>50% primary sludge or greater</td>
</tr>
<tr>
<td>ratio</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volatile solids loading rate</td>
<td>pounds/cubic foot/day</td>
<td>0.1 – 0.2. Overload = 10% greater</td>
</tr>
<tr>
<td>Gas pressure</td>
<td>inches W. C.</td>
<td>16 +/- 2</td>
</tr>
</tbody>
</table>

**Confirm, sample, analyze, record, track/trend and publish**
## PROCESS MEASUREMENT

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<thead>
<tr>
<th>Criteria</th>
<th>Measurement</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Liquid level</td>
<td>feet</td>
<td>Determines active volume</td>
</tr>
<tr>
<td>Freeboard</td>
<td>feet</td>
<td>6 ft or greater from top</td>
</tr>
<tr>
<td>Foam depth</td>
<td>feet</td>
<td>Minimal</td>
</tr>
<tr>
<td>Volatile acids</td>
<td>mg/L</td>
<td>50 - 330</td>
</tr>
<tr>
<td>Alkalinity</td>
<td>mg/L</td>
<td>1500 - 6000</td>
</tr>
<tr>
<td>VA/Alk ratio</td>
<td>mg/L / mg/L</td>
<td>0.1 – 0.2</td>
</tr>
<tr>
<td>Temperature</td>
<td>degrees</td>
<td>95 – 100F (mesophilic)</td>
</tr>
<tr>
<td>Grit accumulation</td>
<td>feet (quarterly)</td>
<td>Lost active volume</td>
</tr>
</tbody>
</table>

Confirm, sample, analyze, record, track/trend and publish
HIGH-TECH MEASURING DEVICE

Works with grit, scum and foam
MAINTENANCE

Cover will not float if it weighs more than the gas can lift
MAINTENANCE – FLOATING COVERS

- Wash off overflow
- Do not store anything on the roof – such as the fan used for venting during cleaning work
- Confirm the pressure relief pallet weights
- Grease the corbels
- Inspect the ballast troughs – make sure the drain ports are open
PHYSICAL IMPROVEMENTS
VIEWING PORTS

Use to determine the foam depth and how much freeboard is available
Stainless steel; extends 9 inches away from sidewall; 8 feet long; Z-shaped jog at every foot
MULTIPLE LEVEL INDICATORS

Compare the bubbler level to the radar level. The difference is foam.

Bubbler works off of pressure. The specific gravity of the digester contents becomes less with more entrained gas.
MOISTURE SEPARATION

Trapped water or foam can stop gas flow.
PRESSURE RELIEF HATCHES

Containment area for small spills

Weighted to open at 2 to 3 inches WC greater than typical gas pressure
FOAM TROUGH WITH SPRAY BAR

Allows the foam to drain out of the digester, but creates other problems where it discharges.
WHAT WAS DISCUSSED

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DIGESTER FOAMING
CAUSES AND SOLUTIONS

Thank you for being a wastewater treatment professional. Be proud of your contributions.