Thermal Process Systems

Digester Optimization

AZ Water
Biosolids Technical Workshop
January 29, 2019

SRP Pera Club, Tempe AZ
Optimal digestion

Combining anaerobic and aerobic digestion
Simplified Sludge Digestion

**Anaerobic**

\[ C_6H_{12}O_6 \rightarrow 3CH_4 + 3CO_2 + \text{Heat (430 kJ/gmol)} \]
Simplified Sludge Digestion

**Anaerobic**

\[ C_6H_{12}O_6 \rightarrow 3\text{CH}_4 + 3\text{CO}_2 + \text{Heat} (430 \text{ kJ/gmol}) \]

**Aerobic**

\[ C_6H_{12}O_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O} + \text{Heat} (2,880 \text{ kJ/gmol}) \]
Anaerobic Digestion

- Popular wastewater treatment
- Process high-strength waste
- Produce biogas to be reclaimed as fuel supplement
Anaerobic Digestion

- Popular wastewater treatment
- Process high-strength waste
- Produce biogas to be reclaimed as fuel supplement

3 stages
- Hydrolysis; solubilize material
- Acidogenesis; formation of volatile fatty acids (VFA)
- Methanogenesis: conversion of VFAs to methane
Anaerobic Digestion

Disadvantages

• In a single tank it can be difficult to control and understand current state
Anaerobic Digestion

Disadvantages

• In a single tank it can be difficult to control and understand current state

• Digester upsets are common especially with variable influent characteristics.
Anaerobic Digestion

Disadvantages

- In a single tank it can be difficult to control and understand current state
- Digester upsets are common especially with variable influent characterizes.
- Final biosolids are often odorous
  \[\text{H}_2\text{S} \quad \text{NH}_4 \quad \text{etc.}\]
Aerobic Digestion

• Reasonable VS destruction
Aerobic Digestion

- Reasonable VS destruction
- Stable Process
Aerobic Digestion

- Reasonable VS destruction
- Stable process

**Resulting biosolids tend to have fewer odors**
Aerobic Digestion

Disadvantages

• Energy consumption is higher than anaerobic
Aerobic Digestion

Disadvantages

- Energy consumption is higher than anaerobic
- **Often inconsistent throughout the year**
Aerobic Digestion

Disadvantages

- Energy consumption is higher than anaerobic
- Often inconsistent throughout the year
- **Foam production**
The combination of these 2 processes maximizes the advantages of each while minimizing their short comings
2-phase anaerobic digestion

- Separate the rapid Hydrolysis & Acidogenesis phases from the slower Methanogenesis
2-phase Anaerobic mesophilic digestion
• Separate the rapid Hydrolysis & Acidogenesis phases from the slower Methanogenesis

Aerobic mesophilic
• Further digestion
• Oxidation of odors
Fresh Material
~50% Primary
~50% WAS
8 gal/day

Acid Tank
99°F
2 day HRT
VFA production

Anaerobic Digester
95°F
15 day HRT
55% VS des
Methane production

Recycle Stream

SNDR
95°F
8 day HRT
15% VS des
Ammonia removal

Processed Biosolids

Anaerobic Processes
(no oxygen)

Aerobic Processes
(oxygen present)
AnAer advantages

- Produce more biogas (~13.5 ft³/lb VS destroyed)
AnAer advantages

- Produce more biogas (~13.5 ft³/lb VS destroyed)
- **Reduce / eliminate digester upsets**
AnAer advantages

• Produce more biogas (~13.5 ft³/lb VS destroyed
• Reduce / eliminate digester upsets
• Control nutrient recycle
AnAer advantages

- Produce more biogas (~13.5 ft³/lb VS destroyed)
- Reduce / eliminate digester upsets
- Control nutrient recycle
- **Maximize volatile solids destruction**
AnAer advantages

- Produce more biogas (~13.5 ft³/lb VS destroyed)
- Reduce / eliminate digester upsets
- Control nutrient recycle
- Maximize volatile solids destruction
- Improve dewaterability
AnAer advantages

<table>
<thead>
<tr>
<th></th>
<th>Average VS Destruction</th>
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<tbody>
<tr>
<td>AD</td>
<td>Mesophilic aerobic</td>
</tr>
<tr>
<td>57.7%</td>
<td>15.3%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>64.3%</td>
<td></td>
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</table>
### AD Biogas Averages

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
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<tbody>
<tr>
<td>Hydrogen Sulfide (ppm)</td>
<td>21.0</td>
</tr>
<tr>
<td>Ammonia (ppm)</td>
<td>6.06</td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>38.1%</td>
</tr>
<tr>
<td>Methane</td>
<td>61.9%</td>
</tr>
<tr>
<td>Biogas produced (ft³/lb VS)</td>
<td>13.47</td>
</tr>
</tbody>
</table>
AnAer advantages

Dewaterability improvements

- Lower demand for coagulants and polymer
AnAer advantages

Dewaterability improvements

- Lower demand for coagulants and polymer
- **Higher cake solids**
AnAer advantages

Dewaterability improvements

- Lower demand for coagulants and polymer
- Higher cake solids
- **Decrease in overall HRT**
AnAer advantages

Dewaterability improvements

- Lower demand for coagulants and polymer
- Higher cake solids

<table>
<thead>
<tr>
<th></th>
<th>Total solids (%)</th>
<th>Coagulant (ml ferric sulfate)</th>
<th>Flocculant (ml polymer)</th>
<th>Cake Solids (%)</th>
<th>Coagulatn (active lb/dry ton)</th>
<th>Flocculant (active lb/dry ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample</td>
<td>1.9</td>
<td>0</td>
<td>5</td>
<td>28.7</td>
<td>0</td>
<td>10</td>
</tr>
</tbody>
</table>
In Review

Highlights of combining anaerobic digestion followed by aerobic digestion

1. Increase methane
In Review

Highlights of combination of anaerobic digestion followed by aerobic digestion

1. Increase methane
2. Decrease volume of solids
In Review

Highlights of combination of anaerobic digestion followed by aerobic digestion

1. Increase methane
2. Decrease volume of solids
3. Control nutrient cycle
Highlights of combination of anaerobic digestion followed by aerobic digestion

1. Increase methane
2. Decrease volume of solids
3. Control nutrient cycle
4. **Increase dewatering efficiency**
Highlights of combination of anaerobic digestion followed by aerobic digestion

1. Increase methane
2. Decrease volume of solids
3. Control nutrient cycle
4. Increase dewatering efficiency
5. **Overall decrease the O&M**
Flow Schematic

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Questions?

Thank you!

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