2PADD // Two-Phase Anaerobic Digestion System

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OUTLINE

→ The Big Picture
→ 2PAD Process Overview
→ Site Specific Discussion
→ 2PAD Technical Discussion
→ General Discussion
   (Group Activity)
→ Questions & Answers
The Big Picture
→ What are Biosolids?

➢ Biosolids is the name for the solid or semisolid residue from the treatment of domestic sewage. #1

➢ Biosolids is a term used by the water treatment industry that refers to treated sludge. #2

→ What are the typical sources?

➢ Biosolids are the nutrient-rich organic materials resulting from the treatment of sewage sludge in a treatment facility. #1

➢ Sludge, or "biosolids," are the byproduct of the treatment of domestic wastewater in a wastewater treatment plant. #2

Source: #1 US EPA #2 WikiPedia
The Big Picture

EPA Regulations

→ 40 CFR Part 503

➢ In 1993, the US EPA released Standards for the Use or Disposal of Sewage Sludge

➢ Established minimum standards

➢ State and local jurisdictions can establish more stringent standards
Three main disposal options

→ Incineration

→ Landfill

→ Land Application
  ↳ Applying biosolids to the land to take advantage of the nutrient content or soil conditioning properties of the biosolids.
  ↳ Can be used as soil amendment, fertilizer, topsoil blend, for erosion control, etc.
Two Standards defined for Pathogen Reduction

→ Class B Biosolids
  - Slight reduction in pathogens
  - Many site restrictions
    - Setbacks from water
    - Animal grazing limitations
    - Control of crops grown and harvested

→ Class A Biosolids
  - Less than detectable limits of Pathogens
  - No site restrictions for land application
2PAD Process Overview
IDI 2PAD

→ Will produce Class A biosolids per 503 Regulations

→ High temperature kills pathogens to below detectable limits

→ Class A biosolids can be land applied without restrictions

IDI 2PAD is certified Under Alternative 6 of PFRP (Process to Further Reduce Pathogens)
2PAD Process Overview

2PAD System for Class “A” Biosolids

- **Hot Water Boiler**
  - Heat addition

- **Digestion Gas**
  - TO GAS COMPRESSORS
    - FOR CANNON® MIXING SYSTEMS

- **Feed Sequencing Tank**

- **Cannon® Mixer(s)**
  - Thermophilic digester
    - SRT ~ 2 days
    - T ~ 55°C (131°F)
  - Heat recovery
  - Supplementary cooling
    - if necessary

- **Cannon® Mixer(s)**
  - Mesophilic digester
    - SRT ~ 10 days
    - T ~ 37°C (99°F)

- **Raw Sludge**

- **Class A Biosolids**
2PAD Process Overview

Control of Pathogens

Key Parameters Required for Pathogen Destruction

→ Solids Retention Time and Thermophilic Temperature
→ Digester Feed Sequence (Intermittent Draw & Fill)
→ Mixing (> 90% Active Volume)
→ Total Fatty Acid (TFA) Concentration
→ Free Ammonia Concentration
2PAD Process Overview

Vector Attraction

Vector Attraction Reduction Requirements

→ Fecal Coliform MPN < 1000/gTS

→ Volatile Solids Destruction > 38%

→ Enterovirus < 1 PFU/4gTS & 3 log reduction

→ Viable Helminth OVA < 1/4gTS & 2 log reduction

MPN = Most Probable Number
PFU = Plaque Forming Unit
2PAD Technical Discussion
Stages of Anaerobic Digestion Process

High Acids Contribute to Pathogen Destruction

- Carbohydrates → Sugars
- Fats → Fatty acids
- Proteins → Amino acids

Acid Forming Methane Forming

First Stage
- Hydrolysis
- Acidogenesis

Second Stage
- Acetogenesis
- Methanogenesis

Thermophilic Digester

Mesophilic Digester(s)
2PAD Technical Discussion

Effect of Temperature on Reaction Rate

Temperature, °F

Mesophilic

Thermophilic

Reaction Rate

80 90 100 110 120 130 140

Temperature, °F
Carried out at Indianapolis Belmont WWTP

- Operated jointly by IDI and Suez - Lyonnaise des Eaux
- Studied pathogen destruction and possible design parameters required

3’ Dia. Feed Tank

5’ Dia. Meso Tank

3’ Dia. Thermo Tank
→ Conditional National PFRP Equivalency Automatic
  “Site-Specific” Approval
→ Designed and operated in accordance with IDI Guidelines
→ Monitor first couple of installations for Enteric Virus and Helminth Ova
→ Batch Process

- Up to 7% solids: \[ DT = \frac{50,070,000}{10^{0.14t}} \]
  - @ 55°C (131.0°F): DT = 24 hrs.
  - @ 58°C (136.4°F): DT = 9.1 hrs.

→ Example: Chattanooga Modified 2PAD

- Class A based on time-temperature
- 59.3°C (138.7°F) for 6 hrs
- System identified as 2PAD-T2
2PAD Technical Discussion

2PAD Model

<table>
<thead>
<tr>
<th>Operating Mode</th>
<th>Draw &amp; fill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feedings/day</td>
<td>2 to 4</td>
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Thermophilic Phase
- SRT: 2.1 days
- Temp: 55°C (131°F)

Mesophilic Phase
- SRT: 10.5 days
- Temp: 37°C (98.6°F)
Inside a 2PAD Plant
Feed Sequencing Tank
→ Manages feed volume to digesters
→ Pre-heats sludge
→ 1/6th daily volume
Thermophilic Digester

→ ~ 2 days SRT

→ ~ 132 °F
Heat Exchangers

→ Controls temperature in digester

→ Recovers heat from thermophilic sludge transferred to mesophilic digester
Controls

→ Interface to PLC

→ Controls ESD System
Mesophilic Digesters

→ ~ 15 days SRT combined
→ ~ 100 °F
→ Conventional tanks
Cannon Mixer System

→ Complete mixing
→ 90+ percent active volume
→ No moving parts
→ Simple to operate
→ Uniformity of Temperature
→ Rapid dispersion of feed sludge
→ Minimize solids deposition
→ Prevent scum formation
→ Prevents foaming
→ Combines mixing and heating
2PAD Plant – Lakeland, FL

Cannon® Mixing Bubble Creation

- Stack Pipe
- Gas Line
- Bell Mouth
- Bubble Generator
Cannon® Mixing Bubble Released

- Stack Pipe
- Gas Line
- Bell Mouth
- Bubble Generator
Cannon® Mixing Bubble Enters Bell Mouth

- Stack Pipe
- Gas Line
- Bell Mouth
- Bubble Generator
Cannon® Mixing Bubble in Stack Pipe

- Stack Pipe
- Gas Line
- Hydraulic Gap
- Bubble Generator
- Open Bottom Generator
The bubble rises pumping the sludge
bursting bubbles mix thoroughly and break up scum
Controls

→ Main control
→ Able to network with ESD
→ Currently not in fully automatic mode
Boilers

→ Heats hot water which in turn heats thermophilic and mesophilic digester contents

→ Burn digester gas and propane
2PAD Plant – Lakeland, FL

Mesophilic Digester System

Gas Handling System
→ Boiler compressors
→ Mixer compressors
→ Sediment trap
→ Flame guard
In Conclusion…
Conclusions

2PAD Highlights

Class A Biosolids

→ PFRP Conditional National Equivalency granted by the EPA PEC after extensive pilot testing
→ No other two-phase anaerobic system has national certification
→ Land application without restrictions

Increased Efficiency

→ Combining high temperature and high acids in same phase maximizes pathogen destruction
→ Reduced SRT - smaller total volume or higher loading
→ Increased volatile solids reduction
→ Increased gas production

Cogeneration
Q & A