Bench-scale Study of Anaerobic Digester Foaming

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Factors that Affect Foaming

- Volatile fatty acid composition
- Hydrophobic substances in the solids
- Filamentous bacteria in the waste activated sludge (WAS)
  - *Gordonia*, *Microthrix*, *Tsukamurella*, *Nocardia*, *Skermania* and *Rhodococcus*
Study Design

- Bench scale reactors
  - Seeding with center well foam vs. known filamentous foam-related cultures
  - Mesophilic vs. thermophilic
  - Acid digestion of feed

- Parameters monitored
  - Nitrogen and phosphorus
  - Volatile fatty acids
  - Foaming potential – alka-seltzer and aeration
  - Gram stains – presence of filamentous organisms

- Daily draw and feed for 3xSRT (SRT ~ 18 days)
Phase I

- Control - feed solids (4.5% dry wt) mix of Primary and WAS
- Inoculation with center well foam
- Inoculation with *Skermania* and *Rhodococcus*
Is it foaming or not foaming?

- Alka-seltzer test
  - Requires 11 minutes to dissolve
  - Foam remains for > 4 minutes after tablets dissolve

- Aeration
  - Aerate with aquarium pump (~1L/min) for 5 minutes
  - Measure $V_0$ and $V_{\text{max}}$

Foamy = alka-seltzer foam remains > 4 minutes, $V_{\text{max}} > 1.2 \times V_0$
Phase I – Gram stain

Not foamy

Foamy
Phase I - VFAs

Total Volatile Fatty Acids (mg/L)

- Control Digester
- Center Well Digester
- Culture Seed Digester
- Feed

Date

Not Foamy

Foamy
Study Design (2)

On-going
- Phase II
  - Control – feed solids
  - Thermophilic
  - Acid digest → thermophilic

Not foamy

Thermophilic

Control

Acid - Thermophilic
Preliminary Findings

- Decreased volatile fatty acid composition of feed associated with foaming
  - Hypothesis: greater proportion of BOD as hydrophobic materials and incorporated into filament membranes
- Character of primary and WAS solids (as affected by season) significant in bench-scale foaming
- Higher densities of filamentous organisms significant in bench-scale foaming
- Thermophilic treatment results in “empty” filaments
Continued Work

- Completion of Phase II
- Statistical analysis of monitoring data
  - Identify factors that change similarly with foaming character at bench scale
  - Evaluate whether acid digestion and/or thermophilic digestion can suppress foaming
- Conduct Phase III next foaming season to confirm findings from above