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# Bench-scale Study of Anaerobic Digester Foaming

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# Factors that Affect Foaming

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- 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

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- 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*



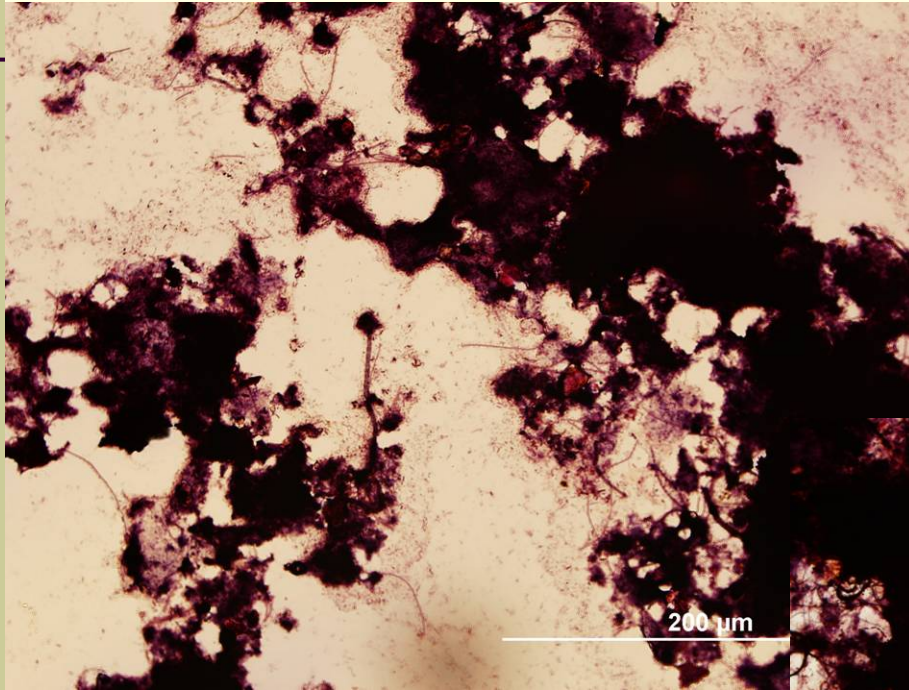
# Is it foaming or not foaming?

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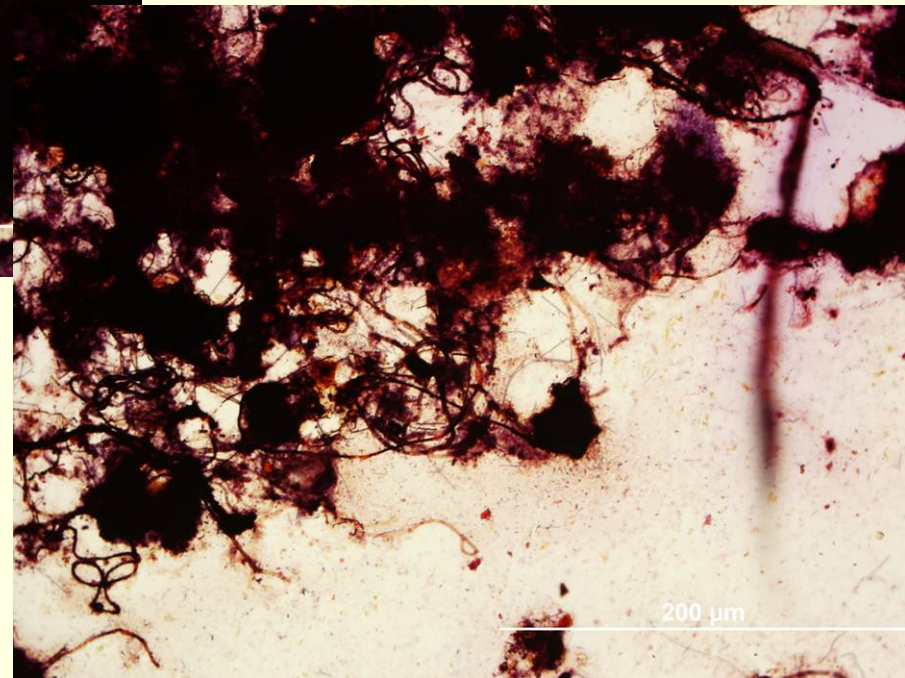
- Alka-seltzer test
  - Requires 11 minutes to dissolve
  - Foam remains for > 4 minutes after tablets dissolve
- Aeration
  - Aerate with aquarium pump (~1L/min) for 5 minutes
  - Measure  $V_0$  and  $V_{\max}$

Foamy = alka-seltzer foam remains > 4 minutes,  $V_{\max} > 1.2xV_0$

# Phase I – Gram stain

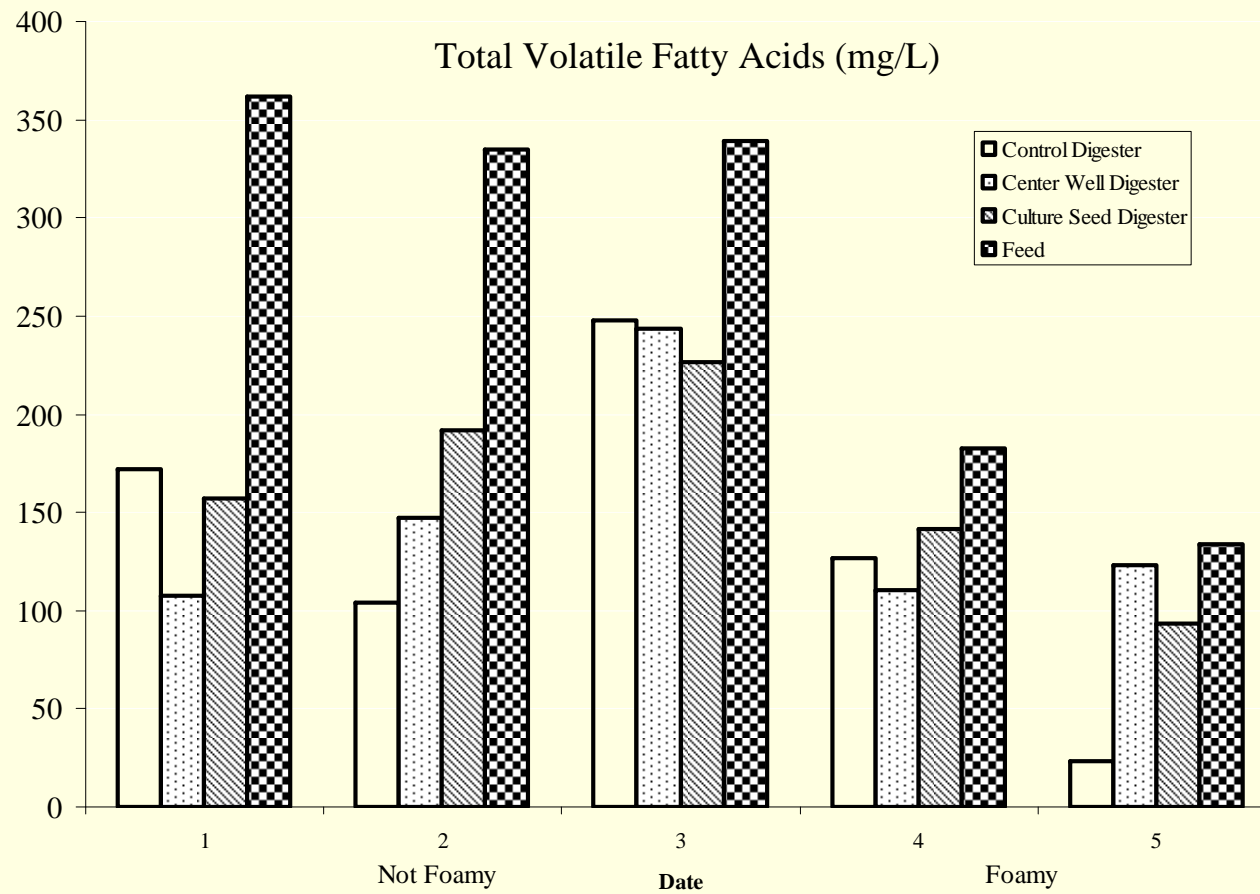


Not foamy



Foamy

# Phase I - VFAs

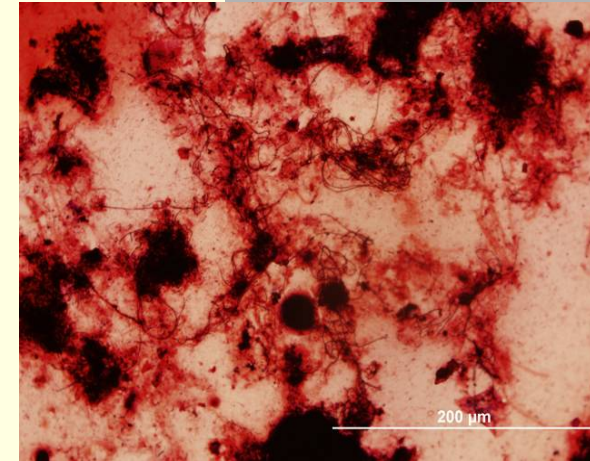


# Study Design (2)

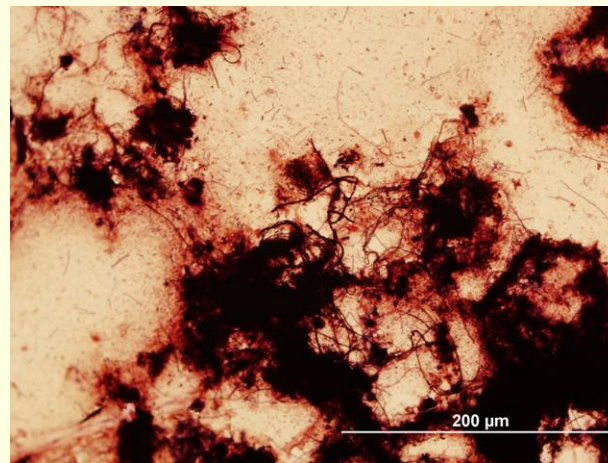
On-going

## ■ Phase II

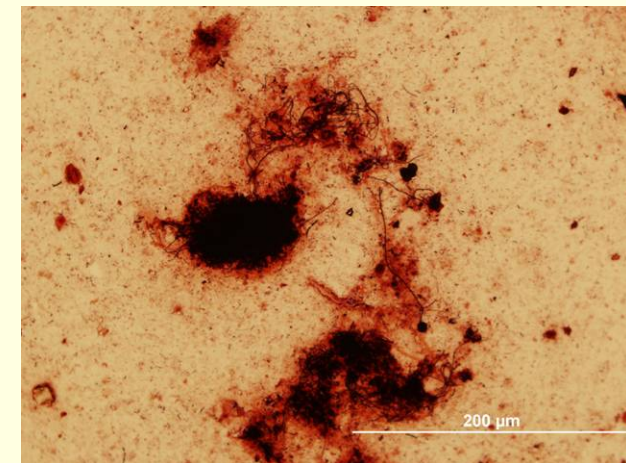
- Control – feed solids
- Thermophilic
- Acid digest → thermophilic



Thermophilic



Control



Acid - Thermophilic

Not foamy



# Preliminary Findings

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- 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

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- 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