Northeast Digestion Roundtable 2018

Quarterly webinars to share technical operations experiences & advance best practices regarding anaerobic digestion in this region.

WELCOME.

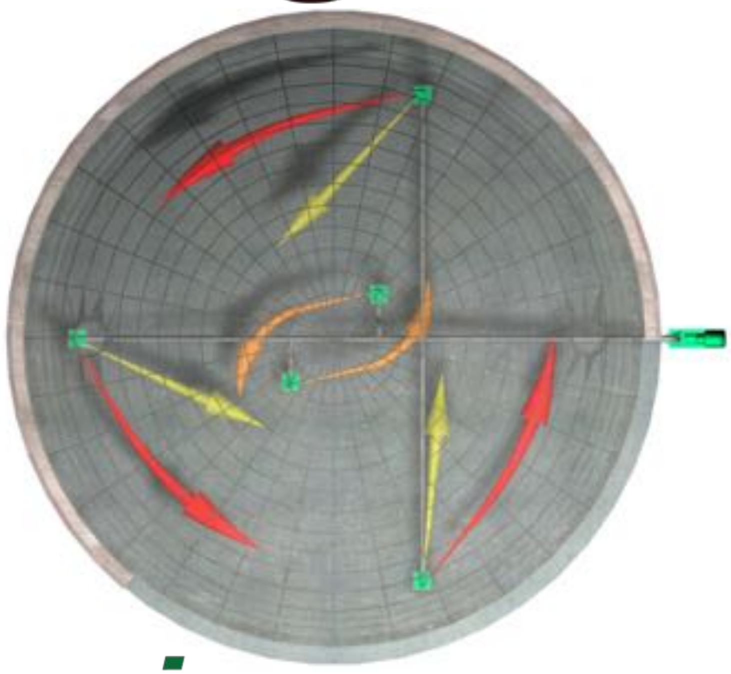
NEDR # 10 is SPONSORED BY:

Vaughan — Unmatched Reliability — Chopper — Triton — Rotamix

INSTRUCTIONS

Unmatched Reliability

Vaughan®

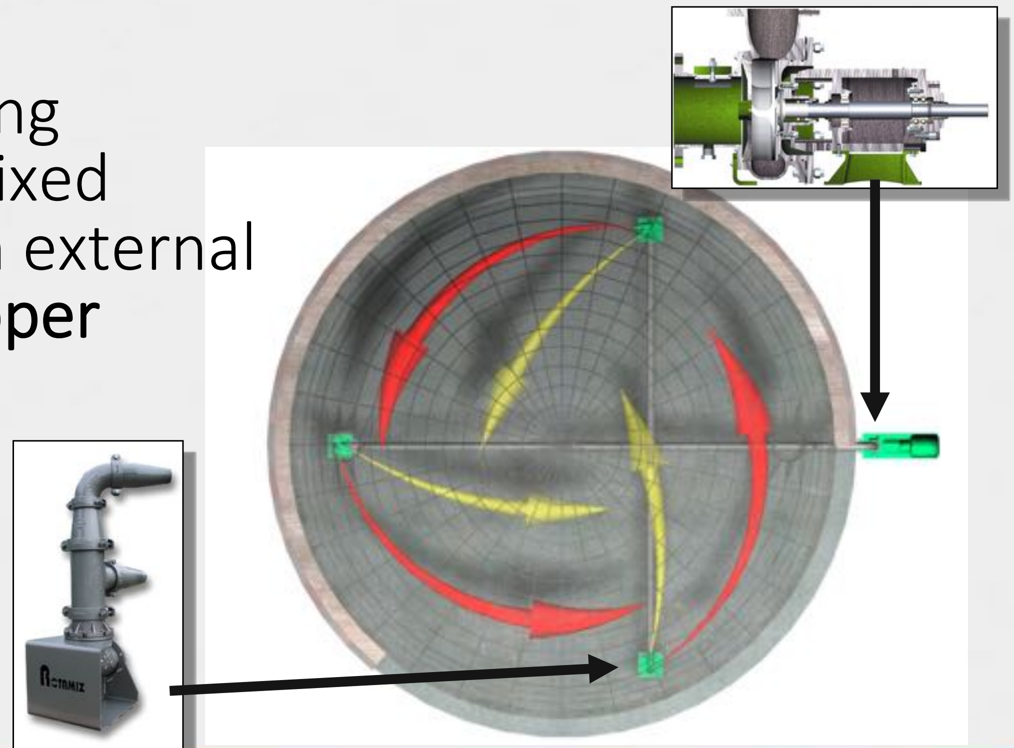


Rotamix®

Process Mixing

Rotamix®

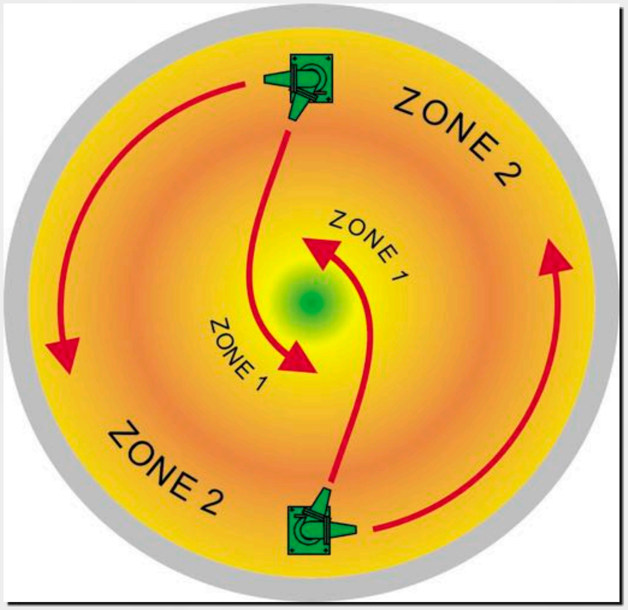
Hydraulic mixing system using fixed nozzles and an external **Vaughan Chopper Pump**



Vaughan
Unmatched Reliability

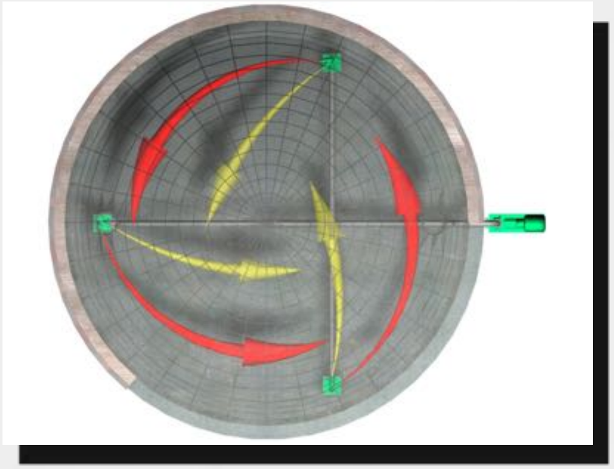
DUAL-ZONE MIXING

- **Zone 1:** Vortical flow pattern, and reduces settling in center of tank
- **Zone 2:** Uniform flow pattern, driving the tank contents.



DESIGN FLEXIBILITY

- Ability to mix multiple tanks with one pump.
- The Vaughan Chopper Pump provides all motive force for distribution of flow while also *continuously breaking down solids.*



WHY USE ROTAMIX?

- Low cost, effective means of mixing
- Easily maintained
- No moving parts in the tank
- Reliable operation using the Vaughan Chopper Pump
- Designs for all geometries
- Guaranteed mixing
- Computerized flow models optimize mixing

Vaughan
Unmatched Reliability

Rotamix®

Applications

- Lime Stabilization
- Anoxic Zone Mixing
- FOG and High Strength (Food) Wastes
- Septage Receiving
- Skimmings Systems
- Influent Channels
- CSO Basins

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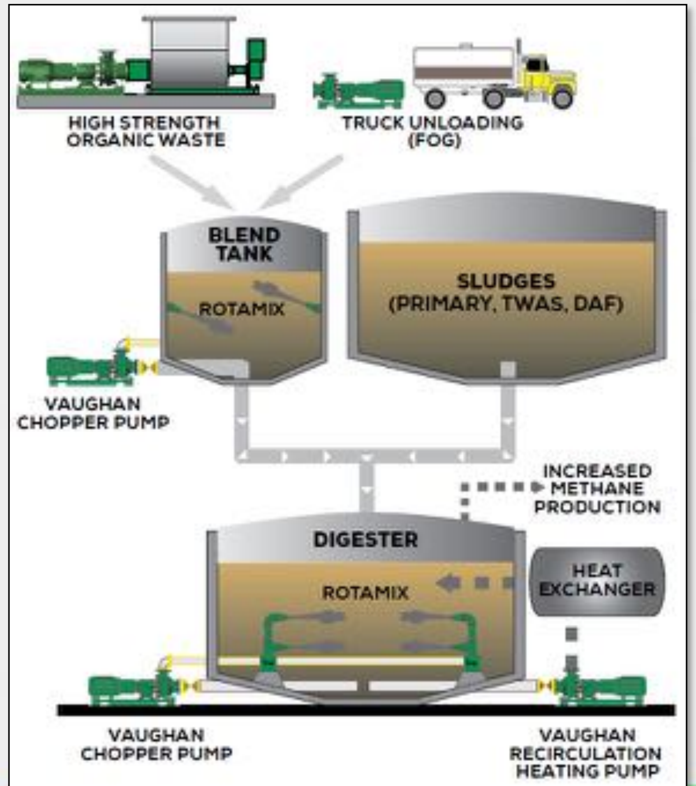
Unmatched Reliability

FOG
(Fats, Oils and Greases)
&
High Strength Wastes (HSW)



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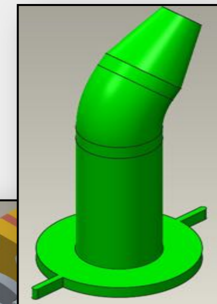
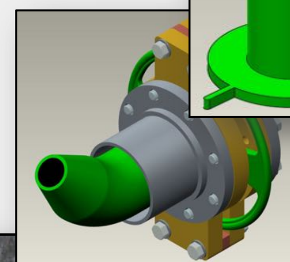
Other Mixing Assembies





- **Externally Mounted Assemblies,** available in several configurations with various features to suit the application .

- Foambuster with
  - **1” thick glass lined nozzle** with 74C Rockwell Har

  - *3M™ Scotchkote*™ 134 Fusion Bonded Epoxy Exterior Coating
  - **10 year** full warranty includes wear

Vaughan
Unmatched Reliability

Rotamix®

Vaughan Chopper Pumps

- Mixing flows to 13000 GPM
- Ability to physically break down solids increases VSR
- Multiple Seal Options
- Self Primer, Vertical Wet Well and submersible pumps offer design flexibility
- Chopping action enhances Volatile Solids Reduction

Self Priming Chopper Pump

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OPERATIONAL ADVANTAGES

- ✓ Flexibility if feedstocks change.
- ✓ Chopper Pump conditions sludge
- ✓ Reduced Energy Option Savings
- ✓ Dual function-mix or load out
- ✓ Not liquid level dependent
- ✓ Optional Foam Suppression

Vaughan
Unmatched Reliability

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INSTRUCTIONS

WERF ENER12R13 :

Understanding Impacts of Co-Digestion:
Digester Chemistry, Gas Production, Dewaterability, Solids Production, Cake Quality, and Economics

PIs

Matthew Higgins, Bucknell University

Ganesh Rajagopalan, Kennedy/Jenks

Technical Advisory Committee

Sudhir Murthy, DC Water

Charles Bott, HRSD

Krishna Pagilla, University of Nevada, Reno

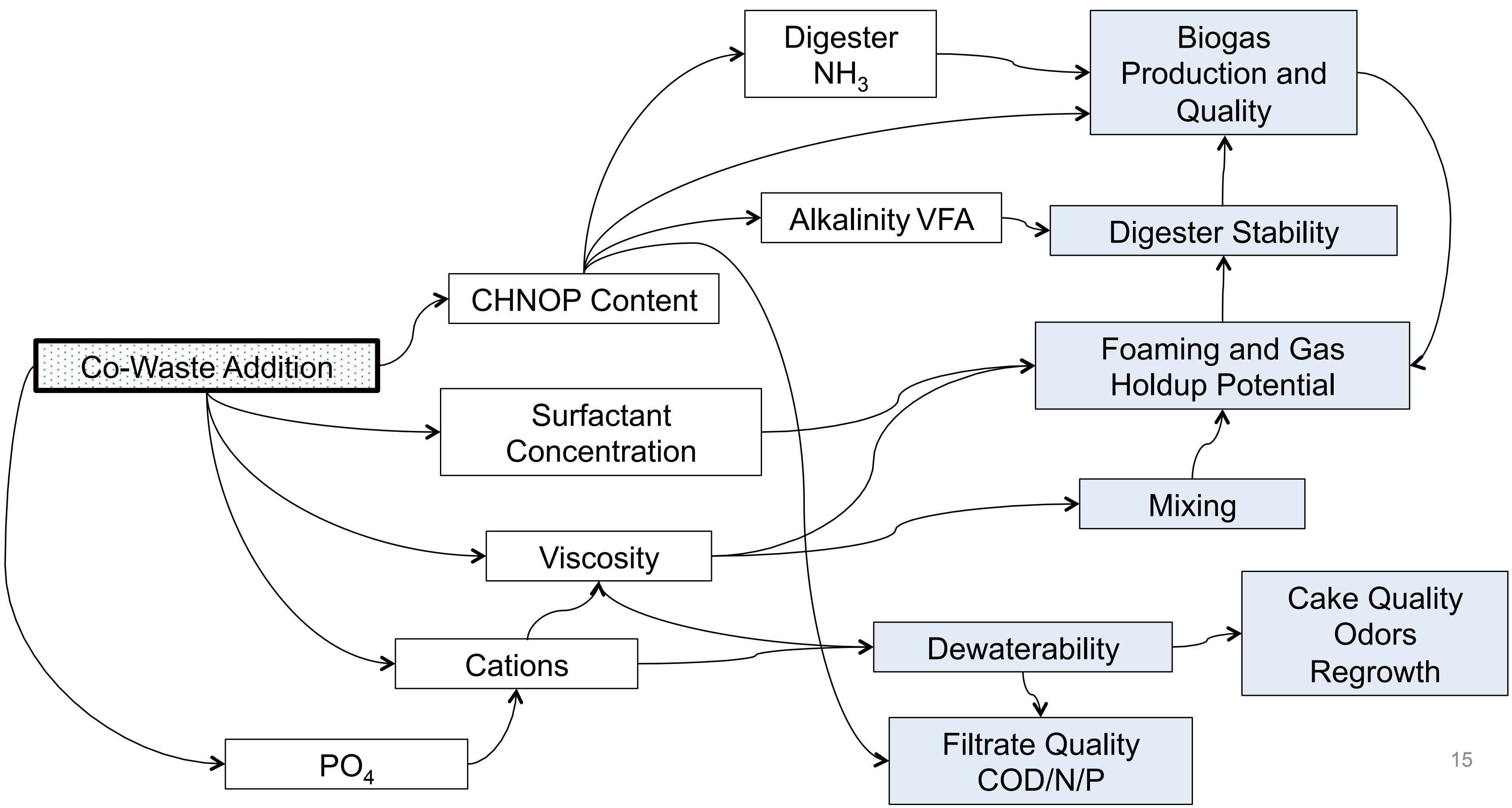
Chris Wilson, HRSD

What Happens When We Add Co-Wastes?

<u>Possible Impacts:</u>

1. Changes in Digester Chemistry
    a. Alkalinity, pH, N, P, VFAs, COD (digester stability and sidestream impacts)
    b. Gas Composition (CH_4, CO_2 ratios)
    c. Gas Production (gas holdup and rapid rise)
    d. Cations: Na, K, Ca, Mg, NH_4^+ (dewatering impacts)
    e. C/N Ratios of solids (cake quality)
2. Changes in Viscosity and Surface Tension
    a. Mixing, gas holdup, rapid rise and foaming, dewatering

Causal Loop Diagram of Effects



Goals of WE&RF Project

Central Goal: Develop Tools to Understand Impacts

1. Develop stoichiometric model
   a. central to predicting digester stability, gas production, chemistry, and side-streams...
2. Understand relationships between
   a. rheology and volume expansion/foaming
   b. cations, anions and dewaterability
   c. CHNO and cake quality (odors)

Phase I Approach: Field Studies

1. Evaluate Full Scale Sites
   - side-by-side control and co-digestion
   - baseline testing followed by co-digestion
2. Characterize
   1. feed in terms of elemental analysis
   2. digester chemistry (pH, Alkalinity, NH_4, etc)
   3. gas composition and production
   4. digester rheology, rapid rise potential
   5. dewaterability and return liquor characteristics
   6. cake quality

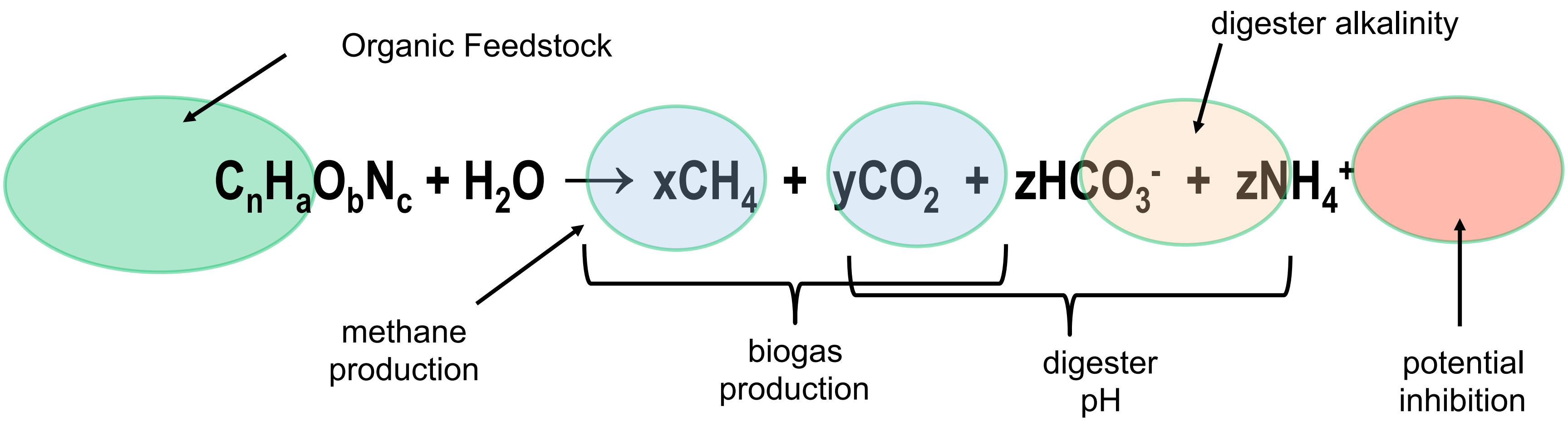
Phase II Approach: Lab Studies

Fill in our knowledge gaps with controlled laboratory digestion studies.

- 10 L active volume
- T = 37 ^{o}C
- High Torque, 100 rpm Motor
- Gas Volume and Rate by Respirometer

Stoichiometry of Anaerobic Digestion

Theoretical General Equation (Buswell, 1952)



$$C_nH_aO_bN_c + H_2O \rightarrow xCH_4 + yCO_2 + zHCO_3^- + zNH_4^+$$

x, y and z are a function of n, a, b, and c

Stoichiometry of Anaerobic Digestion

Parameters we can predict…	**Importance**	**Ranges**
Digester pH	Master variable for digester operation	6.7-7.8
Alkalinity	Helps maintain pH due to high loading	>1000
NH_4^+	Can lead to inhibition at high concentrations, dewaterability effects, side-stream composition	<2800
CH_4 Production	Gas/Energy Production	
Biogas Composition (CH_4/CO_2 Ratio)	Biogas Production and quality	

Stoichiometry of Anaerobic Digestion

Type	Formula	Source
Primary Sludges	$C_{17}H_{31}O_{7.2}N$	Bucknell Data (average of 5 plants)
Waste Activated	$C_{6.6}H_{12}O_{2.4}N$	Bucknell Data (average of 8 plants)
Food Waste	$C_{17}H_{30}O_{6}N$	Bucknell Data (average of 3 different FWs)
Fats	$C_{16}H_{32}O_{2}$	Rittman and McCarty
Carbohydrate	$C_{6}H_{10}O_{5}$	Rittman and McCarty
Protein	$C_{16}H_{24}O_{5}N_{4}$	Rittman and McCarty

Applications of Stoichiometry

1. Evaluate effects of different feed stocks on digester chemistry
    - pH
    - alkalinity
    - ammonia
    - gas production

2. Solve digester chemistry issues:
    - pH (too low or too high)
    - alkalinity (too low)
    - ammonia inhibition (too high)

Scenario 1: Low Loaded Digester

Scenario 1 Inputs:

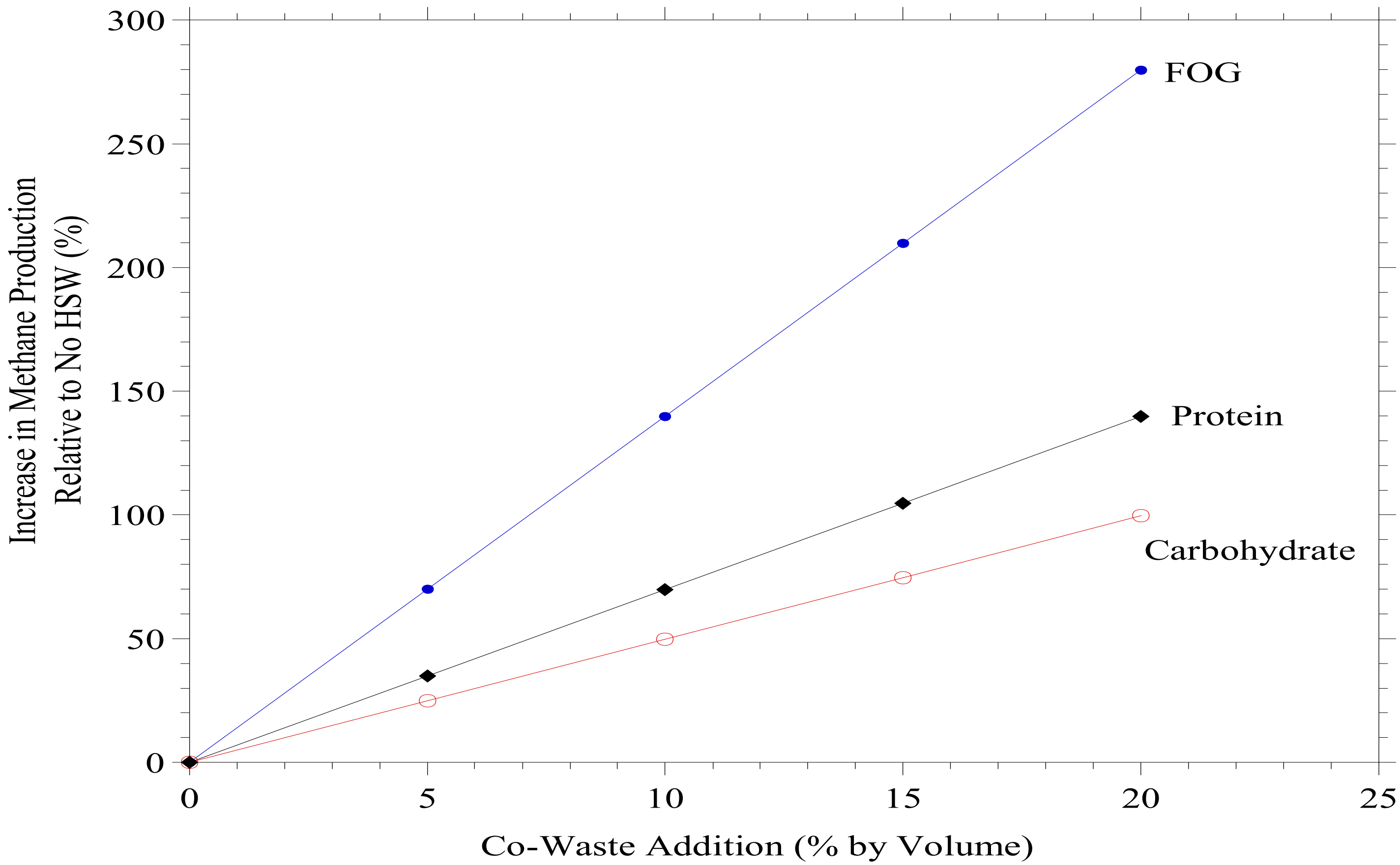
Sludges

- 3% TS Inflow, 50/50 Mix of Primary and Secondary
- 20 d SRT
- VSR = 55%

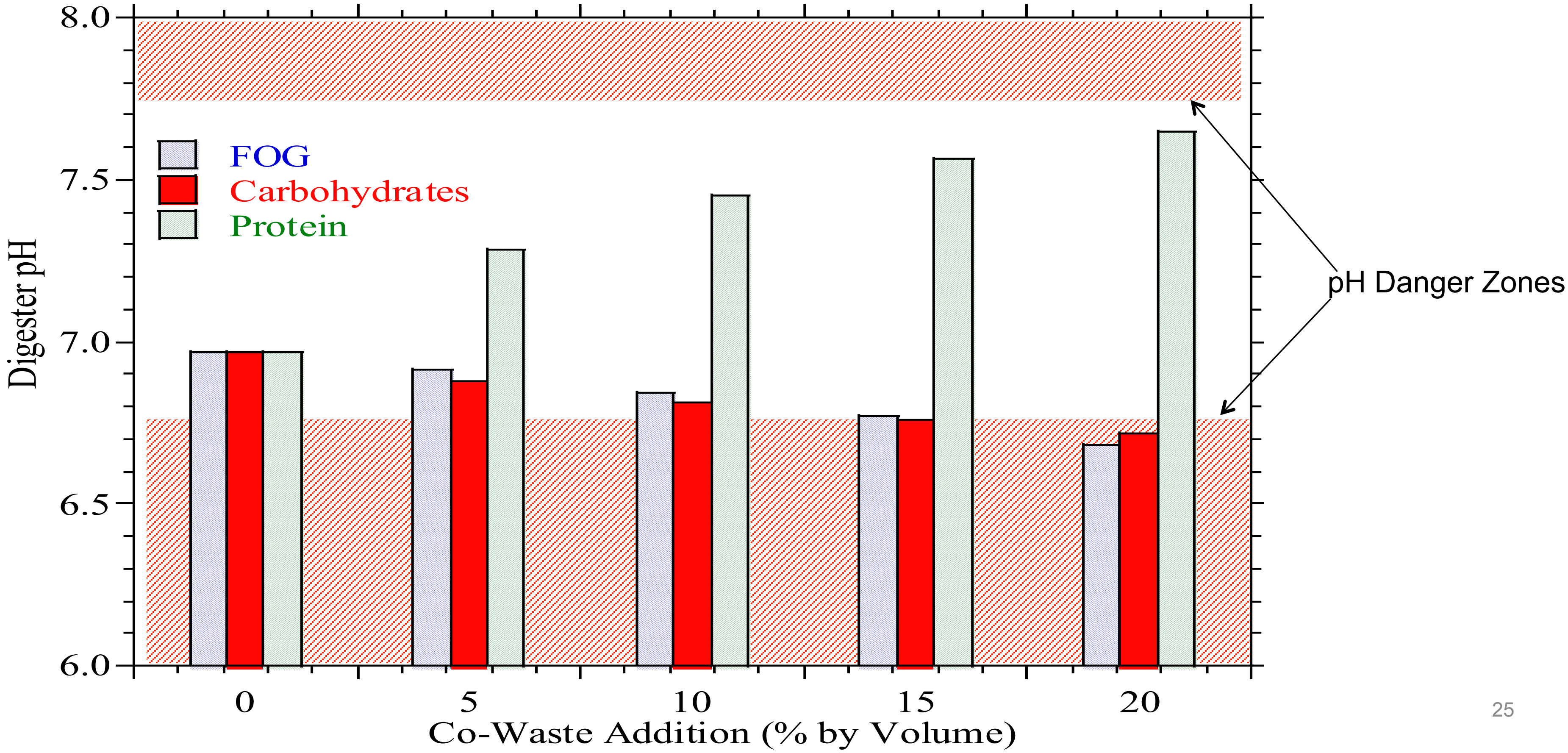
Co-Digestion Feedstocks:

- Fats, Protein or Carbs
- 15% TS, VS/TS = 0.9 80% VSR

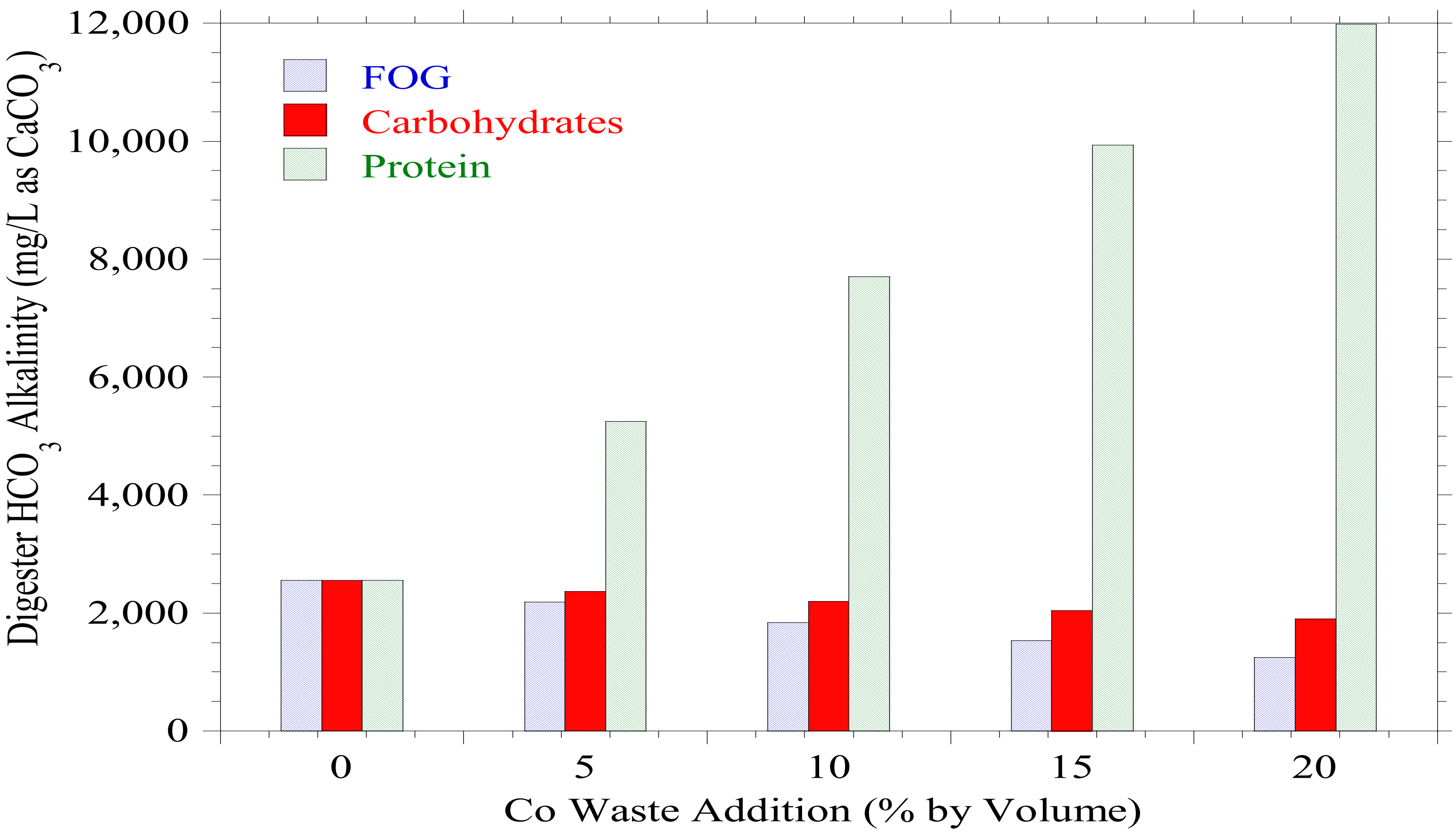
Scenario 1: Effect on Methane Production



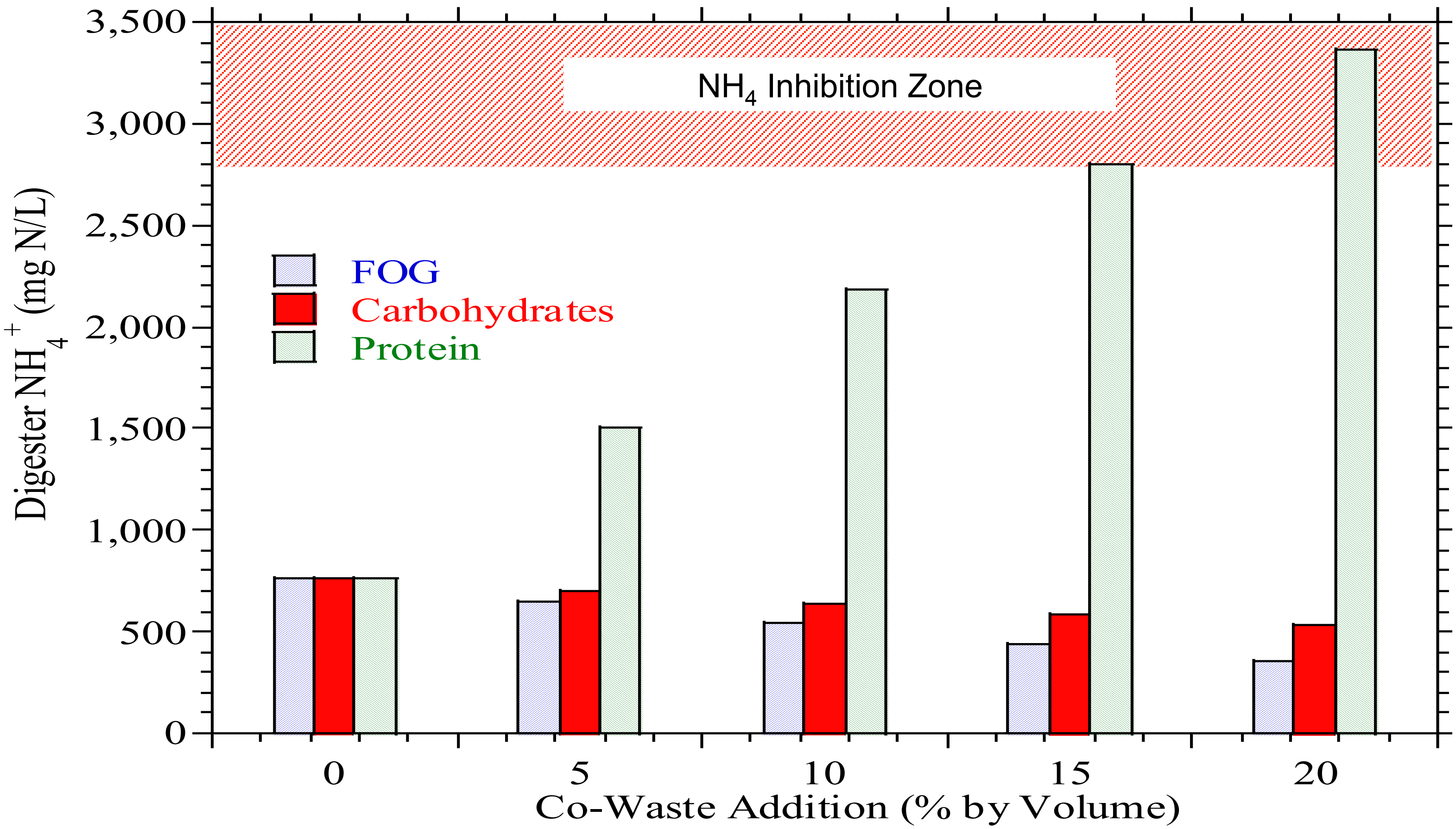
Scenario 1: Effect of Co-Waste Addition on Digester pH



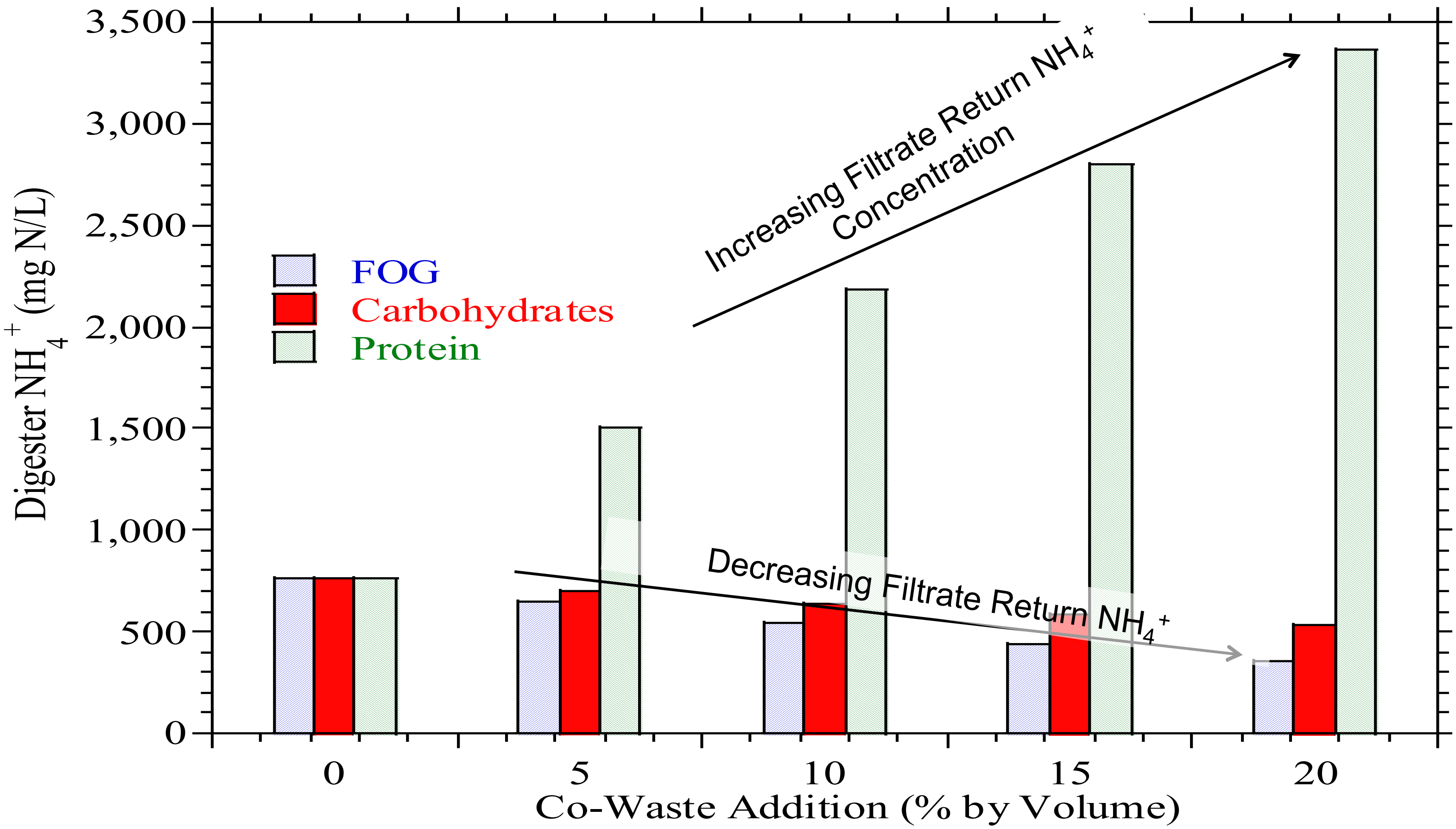
Scenario 1: Effect on Digester Bicarbonate Alkalinity



Scenario 1: Effect of Co-Waste Addition on Digester NH_4^+



Scenario 1: Effect of Co-Waste Addition on Digester NH_4^+



We can use co-digestion to solve digester issues

Issues with *highly loaded digesters* such as thermal hydrolysis:

a. high ammonia concentrations > 3000 mg/L
b. high pH and alkalinity
c. inhibition of methanogens and possibly hydrolysis

Adding low N co-wastes can reduce inhibition by reducing pH and ammonia concentrations while also increasing gas production:

FOG: $C_{16}H_{32}O_2$

Carbs: $C_6H_{10}O_5$

Understanding Impacts

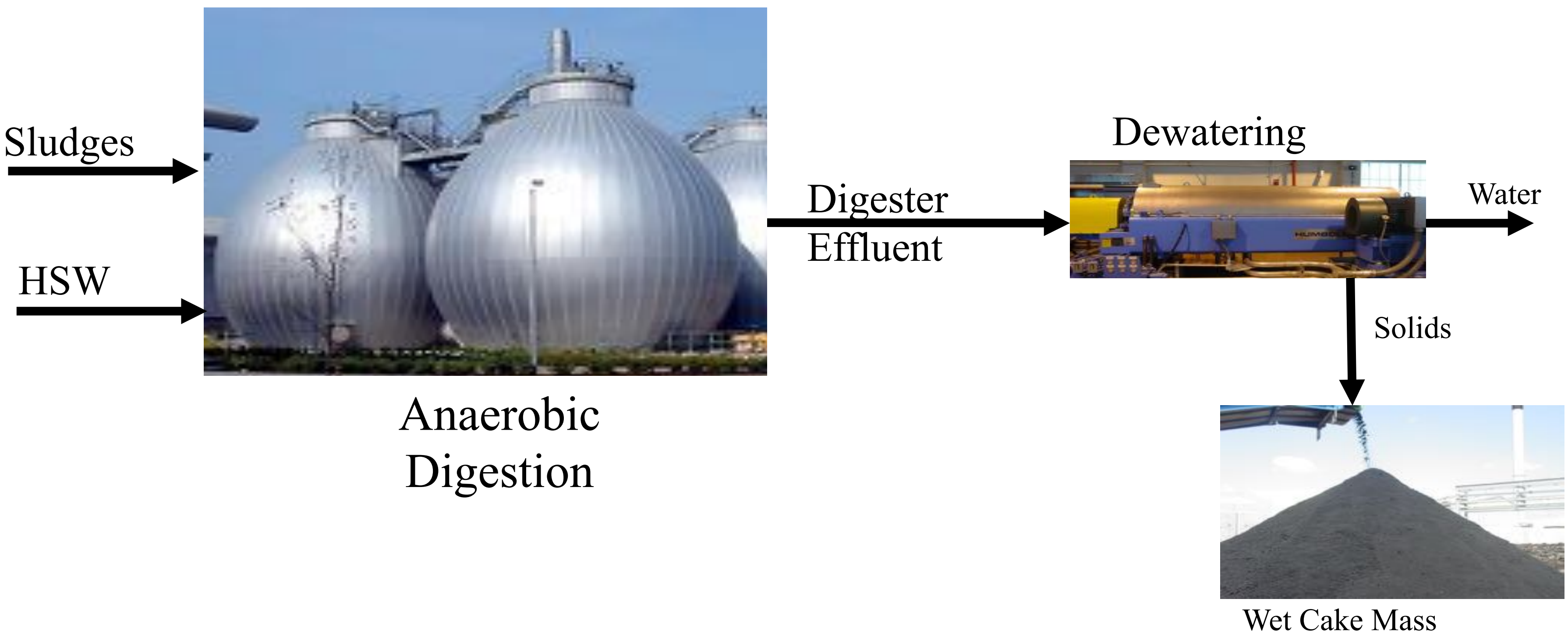
1. Rheology and rapid volume expansion

2. Solids production – net mass of wet cake leaving plant
    a. Dewatering – cake solids
    b. Volatile solids destruction

3. Polymer Demand

4. Effects on cake quality in terms of odors

Effect on Solids Mass Balance

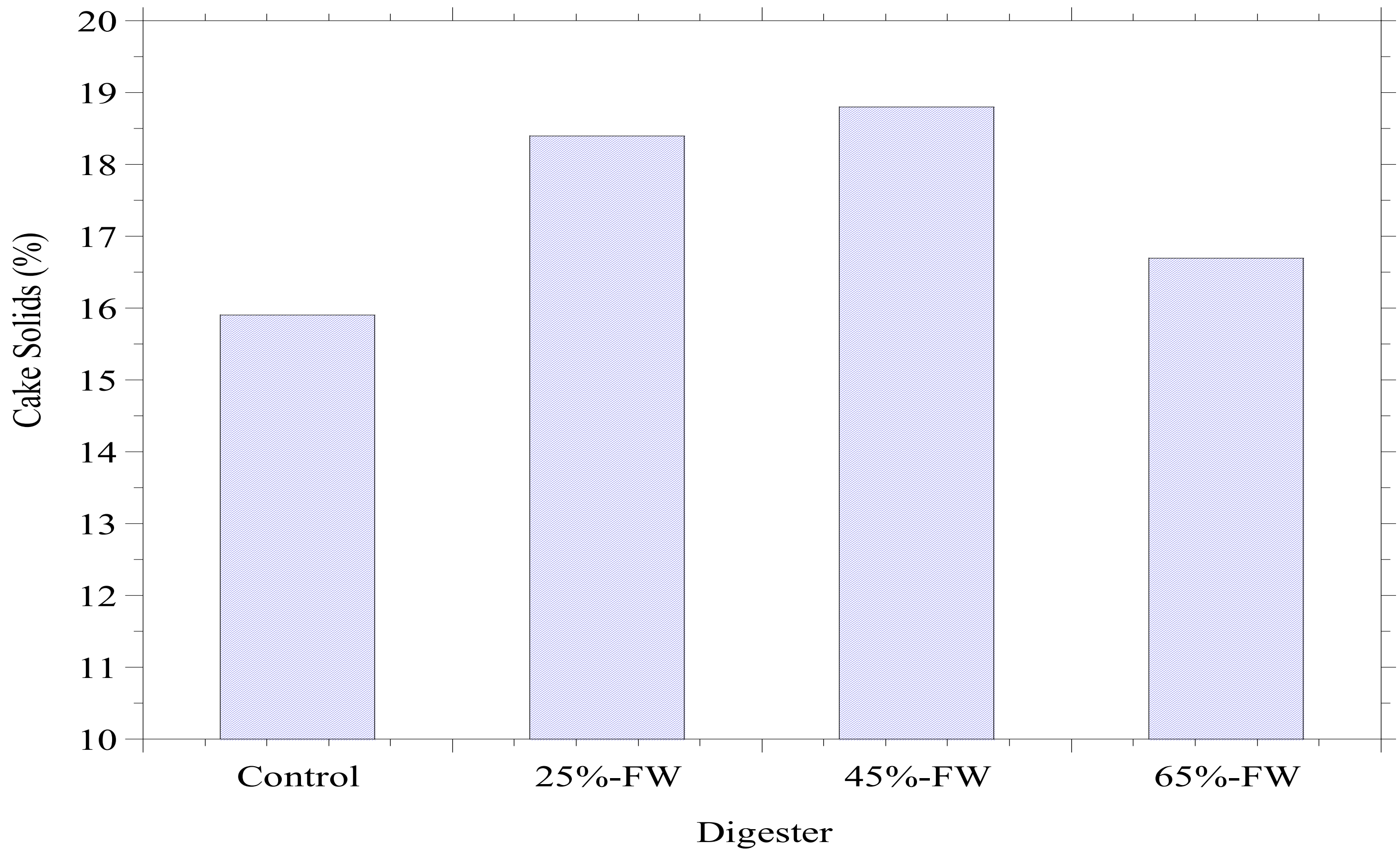


Effect on Solids Mass Balance

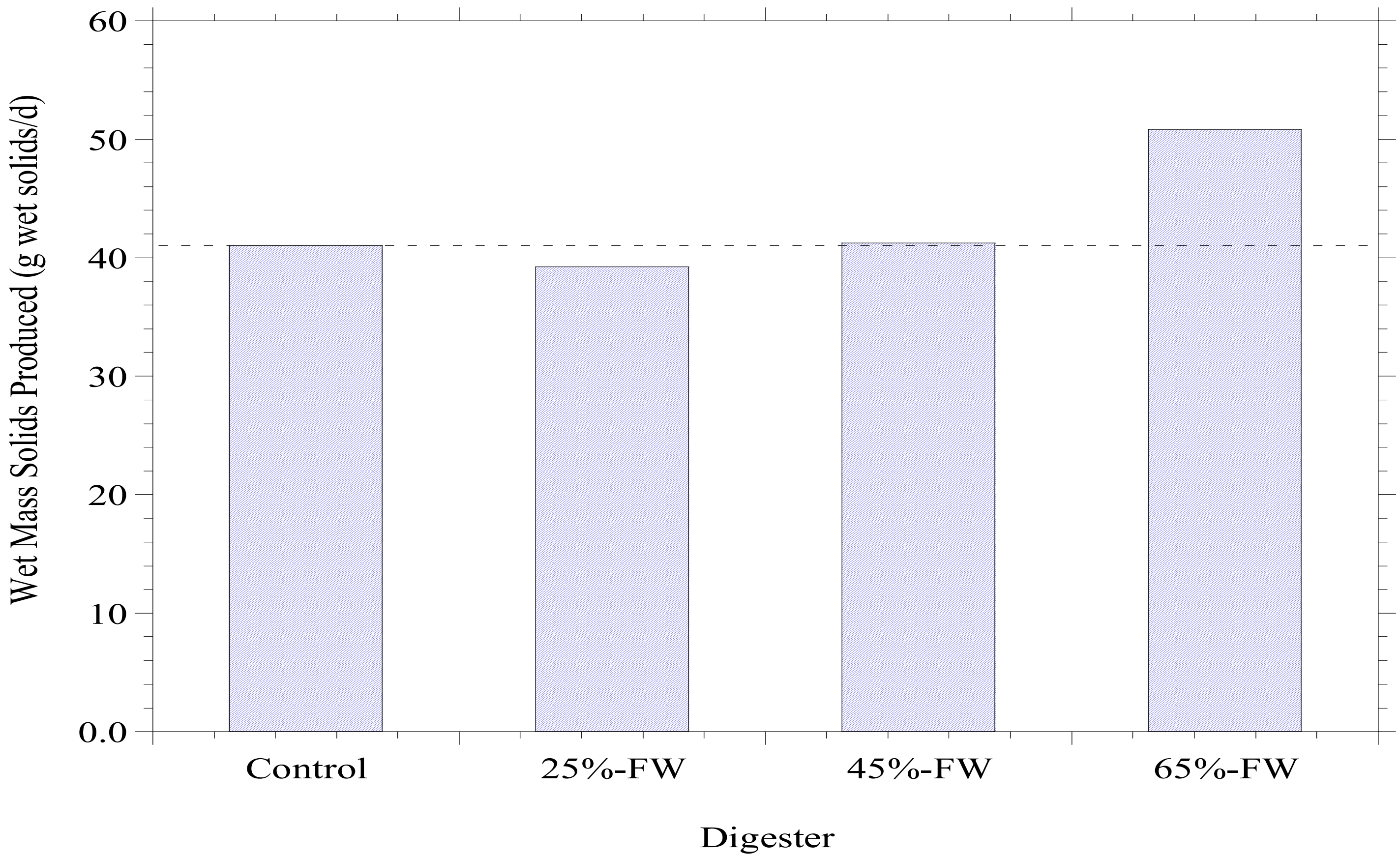
Orange County Project: Waste Management EBS Product (Food Waste)

1. Control – Sludges only
2. 25% additional VS from food waste
3. 45% additional VS from food waste
4. 65% additional VS from food waste

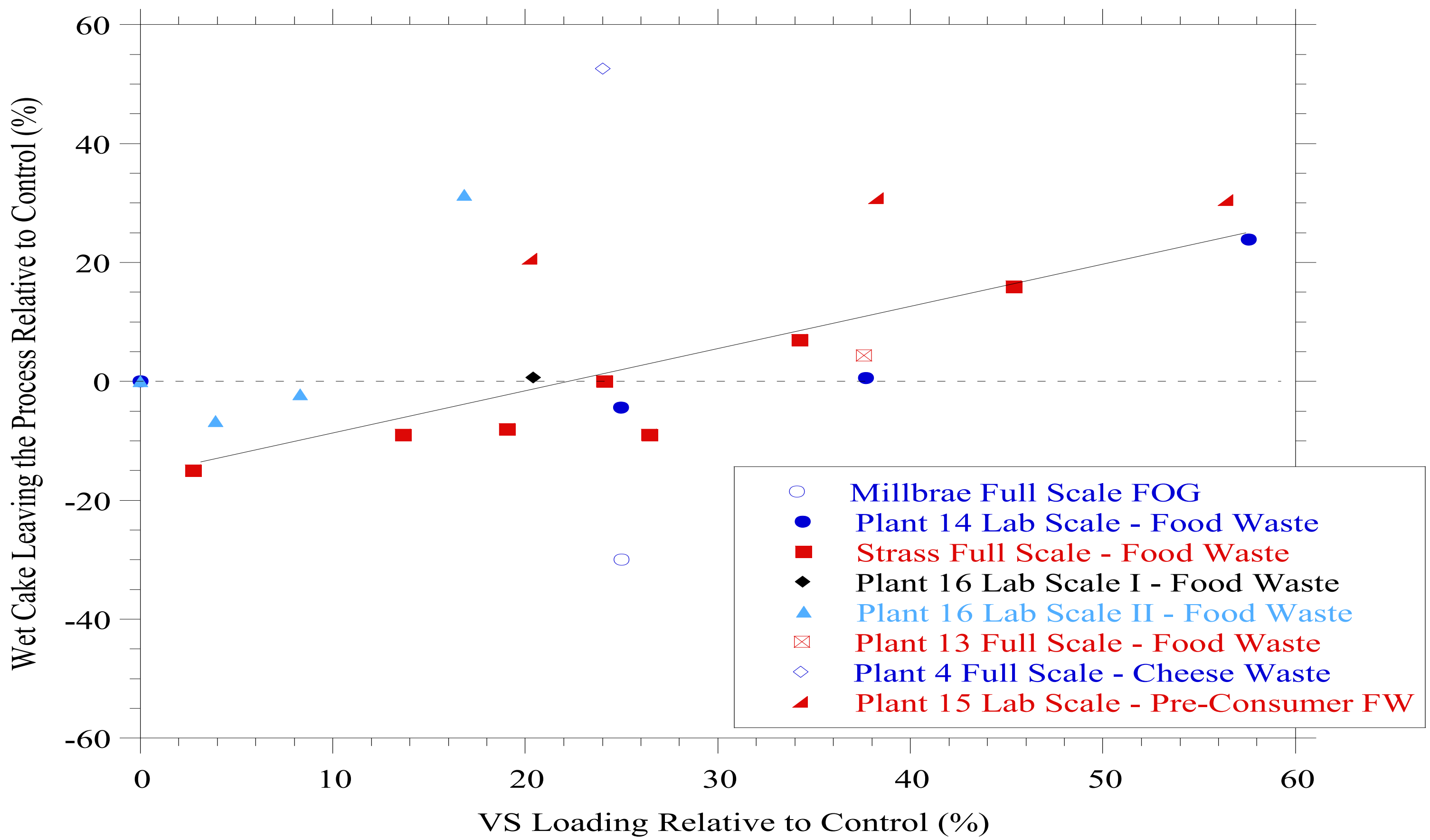
Effect on Dewaterability



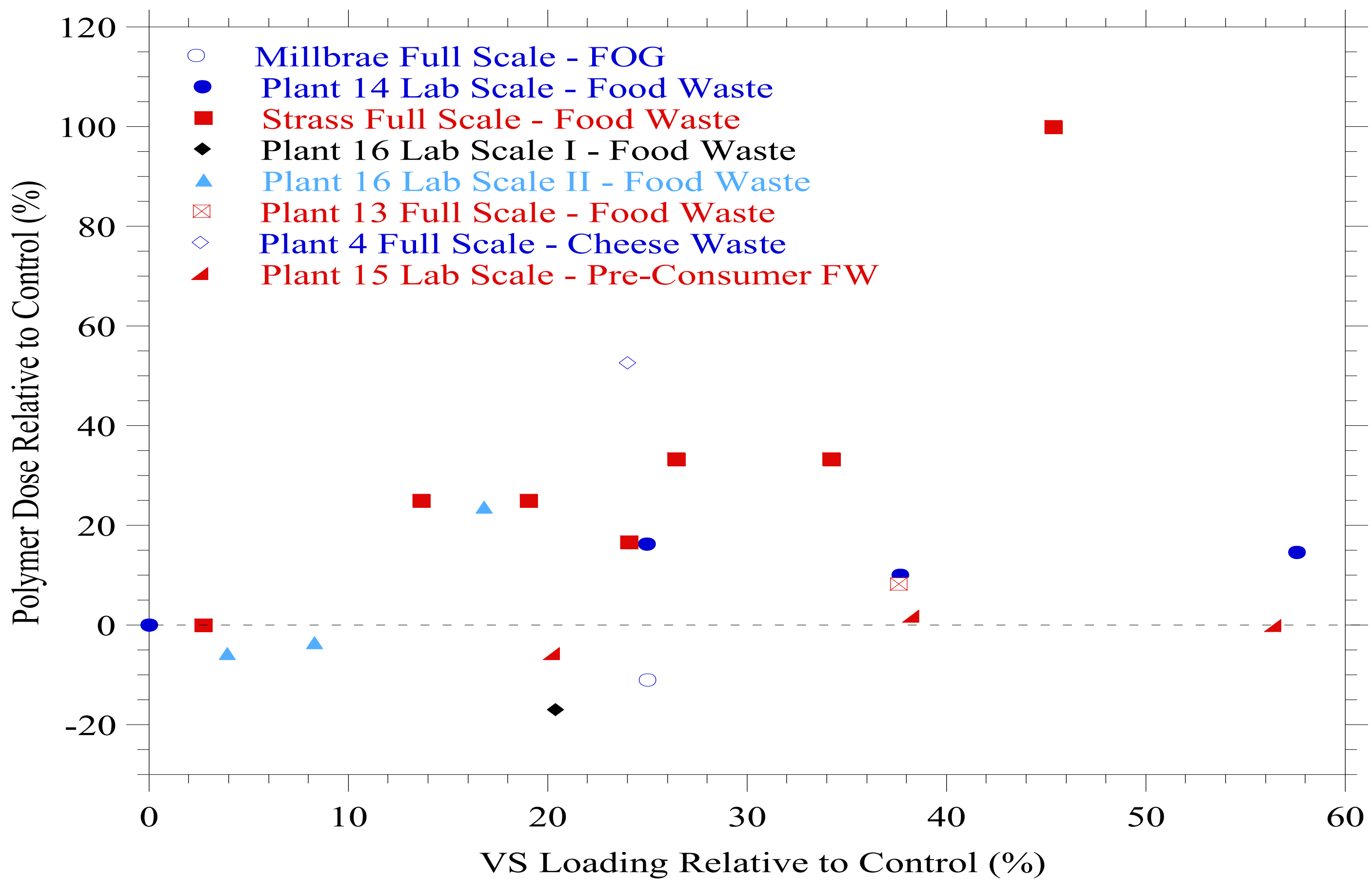
Effect on Solids Production



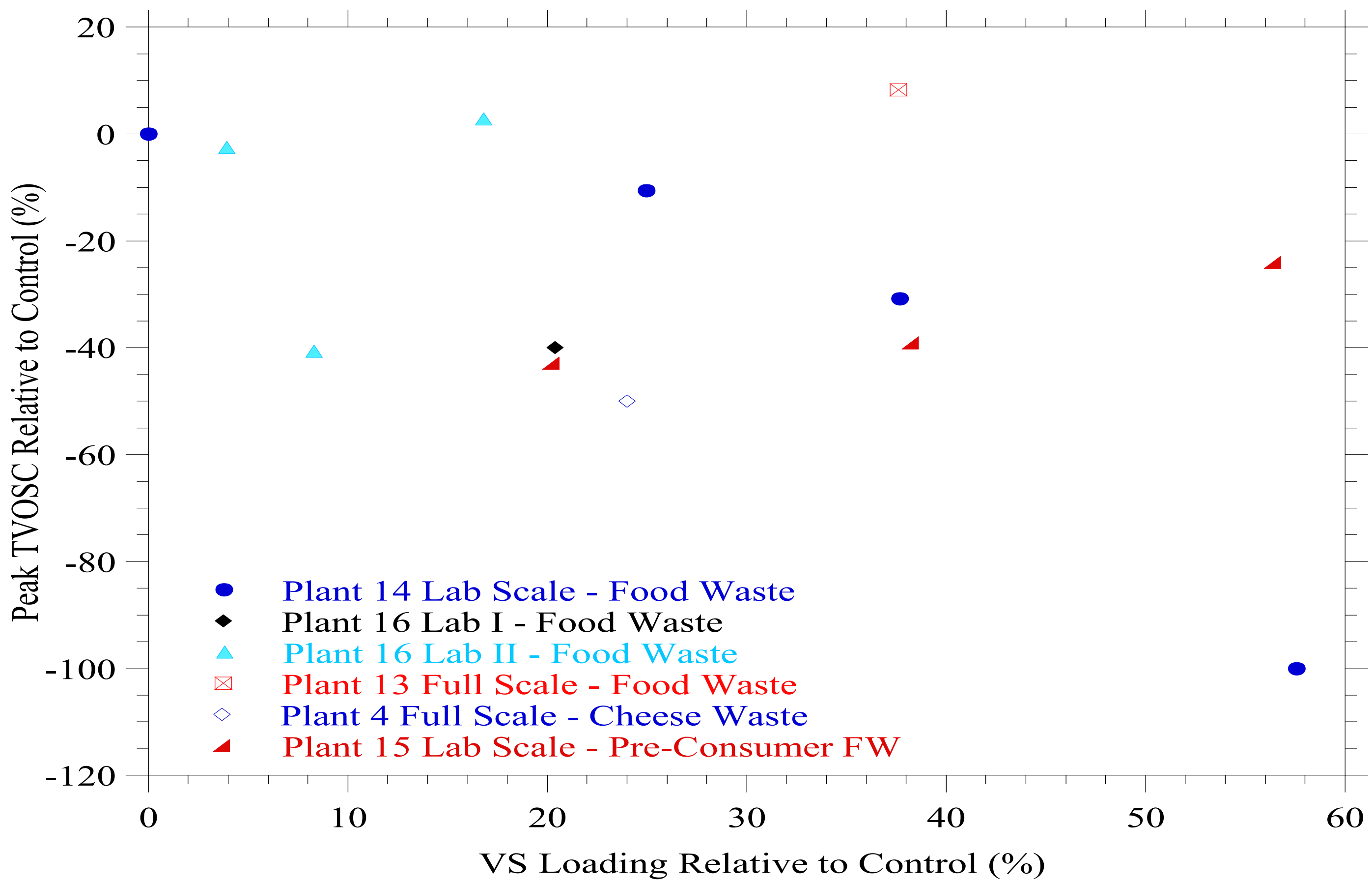
Net Wet Cake Mass Leaving the Plant



Net Change in Polymer Demand



Net Change in Cake Odors During Cake Storage



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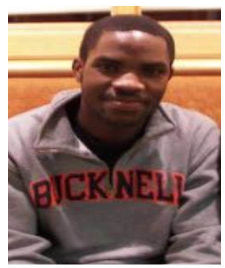

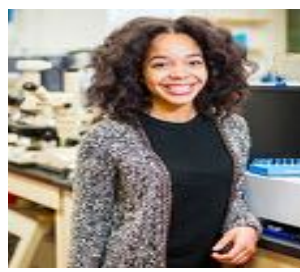

Questions?

Thank you for joining NEDR #10.

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