Panel Discussion

- Anaerobic Digestion (10:00am to 10:50am)
  - Panel Member Introductions
  - Pre-Digestion
  - Digester Loadings
  - Digester Design
  - Digester Process Checks
  - Digester Mixing
  - Digester Operation
  - Digester Gas Handling
  - Digester Safety
  - Digester Equipment
  - Digester Process Analyses
Panel Discussion

- **High Strength Waste (HSW) Receiving (10:55am to 11:45am)**
  - Panel member introductions
  - HSW receiving considerations
  - HSW characteristics
  - HSW feeding
  - HSW substrate types
  - HSW tipping fees
  - HSW haulers
  - HSW impacts
  - HSW tank design
  - HSW other considerations
Fond du Lac Regional Wastewater Treatment and Resource Recovery Facility

- Average Daily wastewater flow to the facility: **8 MGD**
- Digestion (type): **2 Thermophilic followed by 2 Mesophilic**
- Digester Tank (shape): **Pancake**
- Digester Tank (dimensions): **4 at 65ft diameter, 30ft SWD**
- Digester Cover (type): **2 fixed covers and two gas holding spiral floating covers**
- Digester Mixing (type): **Centrifugal horizontal chopper pumps and nozzles**
- Digester Treatment Volume (gal and cu ft): **2,754,000 gal and 368,156 cu ft**
- Average daily flow to digestion:
  - Primary: 30,000 gpd
  - WAS: 40,000 gpd
  - HSW: 32,000 gpd
- Average daily loading to digestion
  - Digester 1: 0.17 Lb VS / ft³  0.27 lb COD / ft³
  - Digester 2: 0.20 Lb VS / ft³  0.23 lb COD / ft³
- Average daily gas production: **200,000 cubic feet**
Wisconsin Rapids Wastewater Treatment Facility

- Average Daily wastewater flow to the facility: 4 MGD
- Digestion (type): 2 Thermophilic followed by 1 Mesophilic (Batch Class A)
- Digester Tank (shape): Pancake
- Digester Tank (dimensions): Thermophilic – 55 ft diameters, 26 ft SWD
  Mesophilic – 70 ft diameter, 26 ft SWD
- Digester Cover (type): 1 fixed cover and 2 gas holding floating covers
- Digester Mixing (type): Compressed Gas Cannons
- Digester Treatment Volume (gal and cu ft): 1,694,000 gal and 226,454 cu ft
- Average daily flow to digestion:
  - Primary: 8,500 GPD
  - WAS: TWAS 17,000 GPD
  - HSW: 10,000 GPD
- Average daily loading to digestions:
  - Lb VS / 1000 cu ft: 150
  - COD / 1000 cu ft: xxxx
- Average daily gas production: 135,000 cubic feet
Appleton Wastewater Treatment Plant

- Average Daily wastewater flow to the facility: **15.5 MGD**
- Digestion (type): **2 Mesophilic**
- Digester Tank (shape): **Egg Shaped Digesters**
- Digester Tank (dimensions): **2 at 110 ft SWD, 80 ft diameter**
- Secondary Digesters Cover (type): **2 conventional with duodeck fixed covers**
- One gas bladder
- Digester Mixing (type): **Centrifugal horizontal chopper pumps and nozzles**
- Digester Treatment Volume (gal and cu ft): **4,400,000 gal and 588,235 cu ft**
- Average daily flow to digestion:
  - Primary: **48,000 gal**
  - WAS: **60,000 gal**
  - HSW: **87,000 gal**
- Average daily loading to digestions:
  - **65 Lb VS / 1000 cu ft**
- Average daily gas production: **750,000 cubic feet**
Fond du Lac Regional Wastewater Treatment and Resource Recovery Facility

- Average Daily wastewater flow to the facility: **1.8 MGD**
- Digestion (type): **One Thermophilic followed by One Mesophilic**
- Digester Tank (shape): **Round**
- Digester Tank (dimensions): **One at 50 ft diameter, 26 ft SWD**
- Digester Cover (type): **One fixed cover and one gas holding floating cover**
- Digester Mixing (type): **Linear Mixer on Thermophilic, no mixing on mesophilic digester**
- Digester Treatment Volume (gal and cu ft): **450,000 gal and 60,000 cu ft**

- Average daily flow to digestion:
  - Primary: **18,720 gal (includes settled WAS)**
  - WAS: ...
  - HSW: **7,000 GPD**

- Average daily loading to digestions:
  - Lb VS / 1000 cu ft: **0.09**
  - COD / 1000 cu ft: **N/A**

- Average daily gas production: **61,000 cu ft.**
NEW Water Resource Recovery Facility- Green Bay Facility

- Average Daily wastewater flow to the facility: **30 MGD**
- Digestion (type): **2- Mesophilic at 98.0°F**
- Digester Tank (shape): **Silo**
- Digester Tank (dimensions): **2- 65ft diameter, 85ft sidewall depth**
- Digester Cover (type): **Fixed steel dome covers**
- Digester Mixing (type): **Centrifugal horizontal chopper pumps (6) and nozzles**
- Digester Treatment Volume (gal and cu ft): **4,400,000 gallons & 586,666 cu ft**
- Average daily flow to digestion: (1-digester in operation, still in start-up phase)
  - Primary: **45,000 GPD- 5% Average Solids Concentration**
  - WAS: **65,000 GPD- 4.5% Average Solids Concentration**
  - HSW: **TBD- No HSW addition at this time**
- Average daily loading to digestions:
  - Daily VS Load: **33,000 lbs/day average**
  - COD / 1000 cu ft: **N/A- Performing full VFA testing**
- Average daily gas production: **235,000 cubic feet (1-digester is in operation with no HSW addition at this time)**
Sheboygan Regional Wastewater Treatment Facility

- Average Daily wastewater flow to the facility: 10 MGD
- Digestion (type): Mesophilic; 3 Primary Digesters, 1 Secondary Digester
- Digester Tank (shape): Pancake
- Digester Tank (dimensions): 3 at 70ft diameter, 26ft SWD; 1 at 60ft diameter, 26ft SWD
- Digester Cover (type): 3 fixed covers (EIMCO); 1 floating-gasholder cover (EIMCO)
- Digester Mixing (type): Ovivo Linear Motion Mixers; 1 -10HP motor per primary digester
- Digester Treatment Volume (gal and cu ft): 2,250,000 gal and 300,802 cu ft
- Average daily flow to digestion:
  - Primary / WAS (2016): 59,000 gpd
  - HSW (2016): 44,000 gpd
  - Primary / WAS (Oct-Nov 2017): 45,000 – 50,000 gpd
  - HSW (Oct-Nov 2017): 0 gpd
- Average daily gas production:
  - Codigestion (2016) : 500,000 – 600,000 cu ft
  - No Codigestion (Oct-Nov 2017) : 80,000 – 120,000 cu ft

Sharon Thieszen (Former Wastewater Superintendent) – City of Sheboygan
City of Waukesha Clean Water Plant

- Average Daily wastewater flow to the facility: **10 MGD**
- Digestion (type): **3 Mesophilic (2 Active)**.
- Digester Tank (shape): **1 Egg & 2 Pancake’s**
- Digester Tank (dimensions): Egg (66ft diameter, 72 SWD), 2 Pancake’s (90ft diameter, 18ft SWD)
- Digester Cover (type): **1 fixed cover (egg), 1 floating cover, & 1 membrane cover**
- Digester Mixing (type): **Centrifugal horizontal chopper pumps and nozzles**
- Digester Treatment Volume (gal and cu ft): **3,078,768 gal and 411,600 cu ft**
- Average daily flow to digestion:
  - Primary: **25 MGD**
  - WAS: **11 MGD**
  - HSW: **0 MGD**
- Average daily loading to digestions:
  - Lb VS / 1000 cu ft: **123 - Egg**
  - Lb VS / 1000 cu ft: **66 - Pancake**
- Average daily gas production: **160,000 cubic feet**
Racine Wastewater Treatment Facility

- Average Daily wastewater flow to the facility: 23 MGD
- Digestion (type): 4 Mesophilic
- Digester Tank (shape): Pancake
- Digester Tank (dimensions): 3 at 90 ft diameter, 1 at 60 ft diameter
- Digester Cover (type): 3 floating covers and one gas holding covers
- Digester Mixing (type): Draft Tube Mixers
- Digester Treatment Volume (gal and cu ft): 4,000,000 gal and 534,722 cu ft
- Average daily flow to digestion:
  - Primary: 70,000 gal
  - WAS: 35,000 gal
  - HSW: 0 gal
- Average daily loading to digestions:
  - Lb VS / 1000 cu ft: 36.6
- Average daily gas production: 200,000 cubic feet
Anaerobic Digestion
Conditioning/Cleaning/Removal Prior to Anaerobic Digestion

• Grit and screenings removal on wastewater
• Sludge screening on feed sludge to digestion
• Waste Activated Sludge (WAS) conditioning
  • Thermal Hydrolysis
    • Pondus
    • Cambi
  • Enzymatic Hydrolysis
  • Other
Digester Loading

- Primary
- WAS
- Blended Sludge (Primary and WAS co-thickened)
- HSW
- Other

Feed Rates
- Continuous feed
- Intermittent feed

- Lb VS / 1000 cu ft
- Lb COD / 1000 cu ft
Digester Loading

- Percent Feed Rate of Primary vs. WAS vs. HSW
- Organic Loading (BOD/COD)
- Hydraulic Loading (Flow)
- Temperature
- % Solids and % Volatile Solids
- pH
Digester Design

- Thermophilic
- Mesophilic
- Primary Digesters
- Secondary Digesters
- Intermediate Tankage
- Egg shaped
- Pancake
- Cylinder
- Other
Digester Covers and Heat Exchangers/Boilers

- Floating
- Fixed
- Gas holder

- Heating Demand
  - Boilers
  - Heat exchangers
Digester Process Checks

- Volatile Acids (VA) – 50 to 300 mg/L
- Alkalinity (ALK) – 1500 to 5000 mg/L
- VA/ALK ratio – 0.1 to 0.35
- Mesophilic Temperature – 95 to 98 degrees F
- Thermophilic Temperature – 122 to 140 degrees F
- Mesophilic solids retention time – 10 to 30 days (WPDES Permit Driven)
- Thermophilic solids retention time – 5 to 12 days
- Organic loading – 100 to 300 lb/1000 cu ft /day
- Gas production – 13 to 18 cu ft / lb VS destroyed
- pH
- DNA analysis
Digester Parameters/Concentrations to Potentially Monitor

- Micronutrients
- Chlorides
- Phosphorus
- Nitrogen
- Potassium
- Sodium
- Sulfides

- Potential Inhibition (if not acclimated)
  - Ammonia – concentrations higher than 3000 mg/L
  - Sodium
  - Calcium
Digester Mixing and Mixing Operation

- Pump – nozzle mix
- Draft tube
  - Internal
  - External
- LM mixer
- Gas mixing
- Other

- Mixing Operation
  - Continuous mixing
  - Intermittent mixing
Digester Operation

- Series
- Parallel
- Primary and/or Secondary
- Withdrawal rates
- Percent solids in
- Percent VS solids in
- Percent solids out
- Percent VS solids out
- VS destruction
- Proper Sampling locations and techniques
Digester Operation

- Recirculation rates of sludge
- Heat exchangers (maintenance)
- Boiler/Heat exchanger operation
- Cleaning of digesters
- Piping considerations
Digester Potential Operational Issues

- Rags, debris, and grit accumulation
- Foaming
- Equipment failures
- Cover issues
- Struvite/Vivianite formation
- Gas handling equipment
- “Rapid Rise” phenomenon
- Corrosion
Condensation removal
Siloxane removal
H2S removal
CO2
VOCs
Ferric addition
Digester Safety

- Explosive Gas (Methane)
- Pressure and Vacuum Relief
- Gas Monitoring
- Lower and upper explosive limits of Methane gas
- Emergency evacuations
- Maintenance
- Gas Leak detection
Digester Equipment

- Pumps
- Boilers
- Heat exchangers
- Piping
- Flow meters
- Temperature Measurement
Digester Process Analyses

- Volatile Acid / Alkalinity Ratio
- pH
- Total Solids
- Volatile Solids
Panel Discussion

• High Strength Waste (HSW) Receiving and Co-Digestion (10:55am to 11:45am)
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  • HSW receiving considerations
  • HSW characteristics
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  • HSW substrate types
  • HSW tipping fees
  • HSW haulers
  • HSW impacts
  • HSW tank design
  • HSW other considerations
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  - Primary: 30,000 gpd
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- Average daily loading to digestion
  - Digester 1: 0.17 Lb VS / ft³  0.27 lb COD / ft³
  - Digester 2: 0.20 Lb VS / ft³  0.23 lb COD / ft³
- Average daily gas production: **200,000 cubic feet**
Wisconsin Rapids Wastewater Treatment Facility

- Average Daily wastewater flow to the facility: 4 MGD
- Digestion (type): 2 Thermophilic followed by 1 Mesophilic (Batch Class A)
- Digester Tank (shape): Pancake
- Digester Tank (dimensions): Thermophilic – 55 ft diameters, 26 ft SWD
  Mesophilic – 70 ft diameter, 26 ft SWD
- Digester Cover (type): 1 fixed cover and 2 gas holding floating covers
- Digester Mixing (type): Compressed Gas Cannons
- Digester Treatment Volume (gal and cu ft): 1,694,000 gal and 226,454 cu ft
- Average daily flow to digestion:
  - Primary: 8,500 GPD
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- Average daily loading to digestions:
  - Lb VS / 1000 cu ft: 150
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Appleton Wastewater Treatment Plant

- Average Daily wastewater flow to the facility: **15.5 MGD**
- Digestion (type): **2 Mesophilic**
- Digester Tank (shape): **Egg Shaped Digesters**
- Digester Tank (dimensions): **2 at 110 ft SWD, 80 ft diameter,**
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- One gas bladder
- Digester Mixing (type): **Centrifugal horizontal chopper pumps and nozzles**
- Digester Treatment Volume (gal and cu ft): **4,400,000 gal and 588,235 cu ft**
- Average daily flow to digestion:
  - Primary: **48,000 gal**
  - WAS: **60,000 gal**
  - HSW: **87,000 gal**
- Average daily loading to digestions:
  - **65 Lb VS / 1000 cu ft**
- Average daily gas production: **750,000 cubic feet**
Fond du Lac Regional Wastewater Treatment and Resource Recovery Facility

- Average Daily wastewater flow to the facility: 1.8 MGD
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  - Primary: 18,720 gal (includes settled WAS)
  - WAS: ...
  - HSW: 7,000 GPD
- Average daily loading to digestions:
  - Lb VS / 1000 cu ft: 0.09
  - COD / 1000 cu ft: N/A
- Average daily gas production: 61,000 cu ft.

Mike Penkwitz (Wastewater Superintendent) – Plymouth
NEW Water Resource Recovery Facility- Green Bay Facility

- Average Daily wastewater flow to the facility: **30 MGD**
- Digestion (type): **2- Mesophilic at 98.0⁰F**
- Digester Tank (shape): **Silo**
- Digester Tank (dimensions): **2- 65ft diameter, 85ft sidewall depth**
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  - Daily VS Load: **33,000 lbs/day average**
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Sheboygan Regional Wastewater Treatment Facility

- Average Daily wastewater flow to the facility: **10 MGD**
- Digestion (type): **Mesophilic; 3 Primary Digesters, 1 Secondary Digester**
- Digester Tank (shape): **Pancake**
- Digester Tank (dimensions): **3 at 70ft diameter, 26ft SWD; 1 at 60ft diameter, 26ft SWD**
- Digester Cover (type): **3 fixed covers (EIMCO); 1 floating-gasholder cover (EIMCO)**
- Digester Mixing (type): **Ovivo Linear Motion Mixers; 1 -10HP motor per primary digester**
- Digester Treatment Volume (gal and cu ft): **2,250,000 gal and 300,802 cu ft**
- Average daily flow to digestion:
  - Primary / WAS (2016): **59,000 gpd**
  - HSW (2016): **44,000 gpd**
  - Primary / WAS (Oct-Nov 2017): **45,000 – 50,000 gpd**
  - HSW (Oct-Nov 2017): **0 gpd**
- Average daily gas production:
  - Codigestion (2016): **500,000 – 600,000 cu ft**
  - No Codigestion (Oct-Nov 2017): **80,000 – 120,000 cu ft**
City of Waukesha Clean Water Plant

- Average Daily wastewater flow to the facility: 10 MGD
- Digestion (type): 3 Mesophilic (2 Active).
- Digester Tank (shape): 1 Egg & 2 Pancake’s
- Digester Tank (dimensions): Egg (66ft diameter, 72 SWD), 2 Pancake’s (90ft diameter, 18ft SWD)
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- Average daily flow to digestion:
  - Primary: 25 MGD
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- Average daily loading to digestions:
  - Lb VS / 1000 cu ft: 123 - Egg
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Racine Wastewater Treatment Facility

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- Digester Mixing (type): **Draft Tube Mixers**
- Digester Treatment Volume (gal and cu ft): **4,000,000 gal and 534,722 cu ft**
- Average daily flow to digestion:
  - Primary: **70,000 gal**
  - WAS: **35,000 gal**
  - HSW: **0 gal**
- Average daily loading to digestions:
  - Lb VS / 1000 cu ft: **36.6**
- Average daily gas production: **200,000 cubic feet**
High Strength Waste Receiving and Co-Digestion
High Strength Waste – Receiving Tank Considerations

- Design goals and preferences based on known and potential substrates to be received
- Tank size
- Tank shape
- Tank placement
- Tank mixing
- Overflow protection/spill containment
- Piping Flushing water and cleanouts
- Sampling
- Odors
- Debris protection and removal
- Access to tankage (hauler travel route, winter operation, tight turns, pavement)
High Strength Waste Characteristics

• Analyses
  • COD
  • BOD
  • Total Solids
  • Volatile Solids
  • Phosphorus
  • Nitrogen (TKN or Ammonia)
  • Potassium
  • Chlorides
  • Magnesium
  • Calcium
  • Sodium
  • Micronutrients
High Strength Waste Characteristics (tests before acceptance)

• Analyses
  • COD
  • BOD
  • Total Solids
  • Volatile Solids
  • Phosphorus
  • Nitrogen (TKN or Ammonia)
  • Chlorides
  • Sodium

• Biochemical Methane Potential (BMP)
• Anaerobic Toxicity Assay (ATA)
  • Marquette – Dan Zitomer
  • Michigan State – Dana Kirk
High Strength Waste Feeding

- % Feed to digestion (Volume and Loading)
  - Volume (gal)
    - % WAS
    - % Primary
    - % HSW
  - Loading (lbs of COD or %VS)
    - %WAS
    - %Primary
    - %HSW
High Strength Waste - Substrates Types

- Dairy Waste
  - Cheese
  - Milk
  - Yogurt
  - Whey (Mother liquor, Permeate, etc.)
- Brewery Waste
  - Yeast bottoms
  - Retentate
- Distillery Waste
- Soda, juice, beverage Waste
- Food Waste
- FOG
- Marinade
- Potato Waste Products
- Chocolate Waste
High Strength Waste Receiving – Tipping Fees

- Cost per gal
- Cost per concentration
- Billing
High Strength Waste Receiving – Haulers

- Distance to travel to the WWTP
- Hours of acceptance at the WWTP
- What else is hauled in the tanks (are they cleaned out prior to hauling)
- Relationship with Haulers
• What substrate gives the most biogas production
• What substrate gives the most issues
• What substrate gives the biggest biosolids impact

• Biogas concentration impacts
  • Methane
  • CO2
  • H2S

• Potential Other uses for substrates
  • Food source (carbon) for Bio-P
High Strength Waste – Impacts to the Wastewater process

- Bio-P
  - High N and P in the recycle streams
- Solids Handling – increase in biosolids
- Effluent Quality
- UV transmissivity
- Increase to the nutrients in the activated sludge system
- Increase in nutrients in the biosolids
- Potential to increase Struvite or Vivianite (if dosing Ferric) formation
- Chemical feed for phosphorus, struvite, and H2S control
- Thickening / Dewatering changes
- Accumulation / Increase in chlorides
• Potential to increase energy costs due to more ammonia recycle
• Potential need for extra carbon for BNR facilities if large ammonia recycle
• Potential increase in phosphorus chemical usage
• Potential to increase volume of biosolids to handle (thicken, dewater, and haul)
• Potential to increase polymer usage and heat requirement to heat the digesters
• Potential impact to percent solids coming off dewatering equipment
• Potential to increase Struvite or Vivianite formation
• Potential increase in chemical costs (for example – Ferric Chloride)
• Potential increase in nutrients along with other parameters such as chlorides and sodium
High Strength Waste – Biogas Impacts

- Biogas storage and conveyance sizing
- Biogas cleaning system size and operation
- Biogas characteristics changing (potential lower methane values)
- Biogas engine/microturbine sizing and runtimes
- Potential it increase maintenance of biogas utilization equipment
High Strength Waste Receiving – Potential Overall Impacts

- Odor generation
- Increased truck traffic
- Increased manpower hours
- Potential increase for digester foaming
High Strength Waste Receiving – Tank Design

• Consideration to WWTP loading design limits
• Tank design goal for volume
• Tank design shape
• Tank mixing preferences
• Tank materials of construction (Concrete, Stainless Steel, etc.)
• Tank placement (below grade or exposed)
• Filling of the tank (gravity flow or pumped)
• Types of pumps used to pump into and out of the HSW tank
• Tank and piping coatings/lining
• Flow metering of the HSW
High Strength Waste Receiving – Considerations

- Overflow protection
- Spill containment (offloading of tankers)
- Odor control
- Debris removal prior to tank (rock trap, coarse bar rack)
- Debris removal from the tank (Vac truck access)
- Access for the trucks/tankers (hauler road, turning radius, fencing, hours of access, cleanup of the area, snow removal)
- Sampling of the high strength waste
- Monitoring of the impacts of the HSW to digestion and the WWTP
- Billing of the high strength waste
High Strength Waste Receiving – Other Impacts and Considerations

• Biogas Utilization System
  • Microturbine
  • Internal Combustion Engine
  • Biosolids Dryer

• Biogas Treatment System
  • Moisture removal
  • H2S removal
    • Media
    • Biological
  • Siloxane removal
High Strength Waste Receiving – Other Impacts and Considerations

• Biogas Treatment System and Maintenance (H2S and Siloxanes)
  • Media types
    • What are the options
    • Where to purchase
  • Frequency of cleaning / media change out
    • What is the basis for determining the change out or cleaning
  • How to sample and confirm H2S and Siloxane treatment
  • Where are siloxane samples sent for analysis
    • What are the levels of siloxanes that are important to watch for
    • Oil analysis
High Strength Waste Receiving – Other Impacts and Considerations

- Microturbine Equipment
  - Heat exchangers
  - Wiring harness
  - Inlet cooling fans
  - Water flow meter
  - Combustion Chamber
  - Ignitor
  - Inlet filters

- Internal Combustion Engine
  - Oil changes
  - Spark plugs
  - Valve lash or valve clearance (gap between rocker arms and valve tappet)
  - Air flow
• Heat exchanger maintenance

• Condensate traps and drains

• Service Contracts

• Air Emissions

• When doing maintenance on biogas utilization equipment important to consider potential impacts to peak demand