Generating Energy Through Co-Digestion

City of Fort Worth
Village Creek Water Reclamation Facility

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April 25, 2014
Metropolitan Water Reclamation District of Greater Chicago
Outline

- VCWRF Description
- Journey to Achieve Energy Independence
  - Gas Turbines
  - JCI Energy Performance Contract
- Co-Digestion Phases
  - Planning
  - Implementation
  - Operation
- Lessons Learned
Water Reclamation Facility
Treatment, Recovery and Reuse

Service to over 1 million customers in 23 communities

Wastewater

Village Creek WRF

Trinity River

Reuse Water

Biosolids

Energy
CITY OF FORT WORTH
VILLAGE CREEK WATER RECLAMATION FACILITY

PERMIT = 166 MGD ADF,
7 BOD, 15 TSS, 2/4 NH₃-N
Journey to Achieve Energy Independence
Electrical Utilization
Energy Production…

Starts at the 14 Anaerobic Digesters
### Operational Parameters

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>RANGE OR TARGET</th>
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<tbody>
<tr>
<td>pH Range</td>
<td>6.8 – 7.4</td>
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<tr>
<td>Temperature</td>
<td>95° – 99°</td>
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<tr>
<td>Detention Time</td>
<td>≥15 Days</td>
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<tr>
<td>Volatile Acids</td>
<td>&lt;500 mg/L</td>
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<td>Alkalinity</td>
<td>~3000 mg/L</td>
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<tr>
<td>Feed Total Solids %</td>
<td>&gt;2.5%</td>
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<tr>
<td>% Volatile Solids Destruction</td>
<td>≥38%</td>
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Operational Challenges

No efficient mixing with gas compression
Operational Challenges

Grit accumulation & loss of treatment volume

Average = 29%
Energy Conservation & Recovery

Achieved with the JCI Energy Savings Performance Contract which goals were:

- To improve energy efficiency and enhance energy reduction
- Total project cost of $36,756,399
- Guarantees an annual O&M and electrical savings of $3,184,757
- 12 year payback
- No rate impact
JCI Energy Savings Performance Contract Projects

Facility Improvement Measures (FIMs):

1. Diffuser Replacement
2. Heat Recovery Steam Generation
3. Digester Mixing & Co-Generation Facility
4. SCADA replacement
5. Anoxic zones
6. HVAC, Power Factor Correction, pump efficiency
Estimated Electrical Savings

- Actual & Estimated Electricity & Gas Expense
- Diffusers & Aeration
- Control Lighting
- Steam Turbines & Co-Digestion

Energy Cost

- 2003
- 2005
- 2007
- 2009
- 2011
- 2013
- 2015
- 2017
- 2019

Energy Cost

- $7,000,000
- $6,000,000
- $5,000,000
- $4,000,000
- $3,000,000
- $2,000,000
- $1,000,000
- $0
Planning Phase

1. Why consider it?
2. Type of substrate
3. Screening sources
4. Financial and contract considerations
Leveraging The Opportunity

Numerous industries in or near Fort Worth with High Strength Wastes (HSW)

- Batter dumps & DAF float from food processors
- Expired / damaged product from soft drink bottler
- Glycerin and organic acids from biodiesel facility
City’s main objective was to assure reliable, long-term, low-risk supply of HSW to increase biogas production.

Potential HSW suppliers identified through pretreatment program
- Contacted with waste characterization surveys
- Evaluated/accepted on a case by case basis
HSW Hauler’s Requirements

- COD > 50,000 mg/L, prefer > 100,000 mg/L
- Pumpable at ambient temperature
- Minimal suspended solids, especially inert solids
- High volatile solids
- No pH adjustment necessary
- No pollutants that threaten digester performance or sludge quality (i.e. heavy metals, sanitizers, sulfates)
HSW Contracting Process

- Conducted by Pre-treatment Services
- Solicit interest from interested parties
- Receive/evaluate potential waste streams
- Procure agreements
  - Accountability, key contact info
  - Contract period
  - Fees
  - Indemnification/liability
  - Delivery mechanisms and time frames (customers arrange for delivery – at their expense – and at prescribed schedule)
Implementation Phase

1. HSW fed to six digesters
2. Improvements to mixing systems
3. Design considerations
4. Design build type project

*Based on Dr. Leonard Ripley’s Slides*
Why Implement Co-Digestion?

1 MG sludge digester:
- 200 lb VSS/kft³-day,
- 75% VSS destruction,
- 10 ft³ CH₄ /lb ΔVSS,
- Methane yield = 8,360 SCF/hr
- Energy yield = 8.0 MM BTU/hr

1 MG co-digestion:
- 2.0 kg COD/m³-day,
- 90% COD destruction
- 6.3 ft³ CH₄ /lb ΔCOD,
- CH₄ yield = 3,940 SCF/hr
- Energy yield = 3.8 MM BTU/hr

47%
Feed Distribution Options

- Send all HSW to the sludge blend tank
- Feed digesters in a “pod” to limit pipe length
- Feed codigesters through a new HSW header
Feed Selected Option

Codigestion Building, Ramp & Tanks

HSW Supply Header

13  11  14  12
Digester Modifications

Mixing: Linear Motion Mixers

Feed: PVC header and valves, open to pulse-feed cycles
Receiving Station

- Dedicated truck ramp, with containment curbs, drain, and wash-down sump
- 30,000-gal mix tank, with chopper pumps, jet mixing and heat exchanger
Metering System

- Two 6,000-gal batch tanks, each with recirculation mixer, and heat exchanger
- PLC to feed operator-specified volume to digesters in pulses.
Operational Phase

1. Receiving station
2. Scheduling deliveries
3. Monitor gas production
4. Monitor performance
Receiving HSW

- Clear through security
- Installation of cameras and good lighting
- Operator/supplier offload to complete manifests
- Offloading takes approximately 30 minutes
- Limited storage (ensure tank capacity to offload)
Scheduling Deliveries

- Started slowly in Sept 2012, with filtrate from Liquid Environmental System’s grease processing facility
- Gradually added other wastes:
  - South Waste
  - Delek biodiesel
  - Coca-Cola
- Others pending
Gradually Increase of Deliveries
Monitor Performance

- Set feed-rate to match expected deliveries (for consistent, effective gas production)
- Sufficient waste to get through the night/weekend
- Monitor (feed rates, waste characteristics, temperature, digester performance, etc.)
Courtesy of Dr. Leonard Ripley
Mass Balance
Performance Monitoring

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<th>DIG#</th>
<th>TEMP.</th>
<th>TS%</th>
<th>TS %VOL</th>
<th>PH</th>
<th>TOT.ALK</th>
<th>VOL. ACID</th>
<th>VA/ALK ratio</th>
<th>TSS(MG/L)</th>
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Lessons Learned

1. Planning is critical
2. Efficient mixing system
3. Balancing sink/sources
Lessons Learned

- HSW planning is critical … know what you’re getting. Village Creek has chosen to be very “picky” about its suppliers to reduce risk of upsets
- Efficient mixing is critical for Co-Digestion
- Balancing financial drivers:
  - Steady, reliable biogas production
  - Divert organic loading from liquid treatment
  - Tipping fee revenue
Challenges

- Equalizing HSW loading from weekdays to weekends
- High temperature of HSW from grease processors greater than 130°F
- Odors from truck unloading
- Balancing heat sink/sources
VCWRF Flying Towards Energy Neutrality… The Sky's the Limit