Grandville CWP Egg Shaped Anaerobic Digester and Bio-gas Cogeneration

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MOORE & BRUGGINK, INC.
Outline

• Brief Project Background
• Why ESD
• ESD Startup
• Cogeneration System
• Energy Management
• Current Performance vs. Design
• Lessons Learned
City of Grandville Overview
Customer Community Overview

- Ottawa County
- Georgetown
- Hudsonville
- Jamestown
- Jenison
- Blendon
Grandville Clean Water Plant
Grandville Clean Water Plant
Why Egg Shaped Anaerobic Digester (ESD)?

- Process
- Footprint
- Cost (life cycle)
  - Cleaning
  - Efficiency
- Client Comfort
- Ability to go to Class A
Anaerobic Digestion

- Relatively Simple
- Known Technology
- Produces two beneficial products with low energy input
How the ESD Works:
How the ESD Works:
How the ESD Works:
How the ESD Works:
Micro-Digestion Style Startup

- Good Seed Sludge starts the process
- Complete Control
- Process Allowed to Acclimatize
- No loss of Bio-Mass
- Steady State Operation Quickly
- Alkalinity Builds Quickly
- Temperature Control
Complete Mixing = Better Digestion = More Biogas!

(and no periodic cleaning!)
Grandville’s Biogas Components

- Egg-shaped Anaerobic Digester
- Flare
- Splitter Skid
- Gas Storage
- Gas Cleaning
- Cogen Unit
- Boiler
Why Biogas Cleaning?

• Biogas Impurities
  – Moisture
  – H2S
  – Siloxanes
Siloxane Damage to Boiler

Silica Layer
½” to 1” Thick

Pitting of Boiler Tubes
Siloxane Damaged Valve
Cogeneration System

- Dual Fuel (bio-gas and natural gas)
  - 280 kW using Bio-gas,
  - 360 kW using Nat Gas
- Internal exchangers to capture heat from engine cooling jacket and exhaust
- Efficiency of 86%
Heat
Integrated Energy Management System (IEMS)

- ESD – Biogas Supply
- ESD – Heat Demand
- CHP – Biogas Demand
- CHP – Heat Supply
- CHP – Power Supply
- System – Power Demand
- Lab/Ops – Heat Demand
Biogas Production

• Biogas Quantities
  – Currently producing ~120,000 cuft/day
  – Distribute between cogen, flare, and boiler
Power & Heat Production

• 70,000 CF/day Biogas to CHP
  – Biogas Energy Content ~ 640 BTU/CF
  – Average Energy Demand ~ 175 kW
    • ~ $100,000 / year (@ $0.065/kWhr)
  – Electrical Efficiency 32%
Power & Heat Production

• 70,000 CF/day Biogas to CHP
  – Biogas Energy Content ~ 640 BTU/CF
  – Average Heat Production: ~ 1.0 MMBTU/hr
    • Other than coldest periods of winter, heat production exceeds demand
    • Load Dump Radiator eliminates excess heat
  – Fuel to Heat Efficiency 54%
  – Overall Efficiency 86%
Power & Heat Production

• (+) Producing sufficient heat to satisfy demand of ESD and Lab Ops during coldest periods

• (-) Connected load is frequently not large enough to use all of the biogas being produced
Optimization

• Optimization of ESD Gas Production
  – Balancing gas production with feeding times and quantities
  – Maintaining cleansing velocity in line
  – Look at potential co-feed feedstocks
  – Storage

• Optimization of Power Production
  – Not using all the biogas – still flaring
  – Add loads
Costs and Payback

• Elements of Capital Costs for Payback Analysis
  – Gas Cleaning Skid
  – Cogen Unit
  – Hot Water Pumps for Cogen
  – IEMS system
  – PEX lines to Lab/Ops

Total “Additional” Capital = $850,000
Estimated Savings

- Projected Energy Savings at Startup Rates
  - $95,000/yr
- Projected Gas Savings at Startup Rates
  - $47,000/yr
- Projected Payback
  - 6 years simple, 7.8 discounted
Actual Savings

• Actual Energy Savings
  – Approx $98,000/year

• Actual Gas Savings
  – Approx $22,000/year – Nat Gas is ½ price

Utility bills have been lowered even with expanded plant!
Approximately 25% of plant power is produced with CHP generator.
Where are we at today?

• Consistently producing between 170-200 kW power.
• Providing all heat necessary for digester and Lab/Ops.
• Balancing sludge feed rates to optimize gas production.
• Balancing heat draw from digester to better match production from cogen.
• Reviewing feasibility of another transfer switch.
Going Forward

- Dial in Feed Rates
- Review and Optimize Load Usage vs. Energy Production
  - Consider additional transfer switch
Going Forward

- Review Heat Usage vs. Production from Cogen
  - Consider removing tubes from ESD HX
Lessons Learned

• Micro-digestion
• Startup support
• Power Connection to Turbo-blowers
• Gas holder cover on old tank
• 3-way Valve Plug Coating Material vs. Temp
• Excessive Moisture in Bio-gas
• Improved primary efficiencies
Questions?

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