Basis of Design of LAWPCA Anaerobic Digestion/Energy Recovery Facilities

Presented at Anaerobic Digestion and Energy Generation Workshop and Open House

Lewiston Auburn Water Pollution Control Authority
## Basis of Design of LAWPCA Anaerobic Digestion/Energy Recovery Facilities

- Introduction
- Existing Biosolids Practices
- Project Drivers
- Reasons for Anaerobic Digestion
- Digester Operational Modes
- Digester Types, Mixing Systems
- Description of LAWPCA Digesters
- Description of Combined Heat and Power
Existing Biosolids Management Process

- Waste Activated Sludge
- Primary Sludge
- New Gravity Belt Thickeners
- Gravity Thickener
- Thickened Sludge Storage
- Composting
- Lime Conditioning and Land Application
- Belt Filter Presses
- Landfill
Project Drivers

- Biosolids Management Issues
  - Production exceeds capacity of Composting Facility (18 years old)
  - Remaining biosolids land applied or landfilled
  - Sites for land application are harder to permit and farther from LAWPCA
Project Drivers (Continued)

- Costs are increasing:
  - Amendment for composting
  - Lime for Class B Land Application
  - Fuel costs to transport to land application or landfill
  - Landfill tipping fees
Why Anaerobic Digestion?

- AD is well established technology
- Thousands of operating installations
- AD meets Authority’s goals:
  - Reduces biosolids by significant amount (~40%)
  - Reduces amount of electricity purchased from the grid
Biosolids Process with Digestion
Digester Operational Modes

- Mesophilic Anaerobic Digestion
- Thermophilic Anaerobic Digestion
- Temperature-Phased Anaerobic Digestion
- Acid-Gas Anaerobic Digestion
- Autothermal Thermophilic Digestion
- Dual Digestion
Digester Types
Gasholder Cover - Model GX by OTI 110-ft dia. Toronto, Ontario

- Designed for 30-in w.c.
- Gas storage of 66,000 ft³
Egg Shape Digesters
Submerged Fixed Cover Design

- Enclosed cover eliminates odor and foam release
- Foam & scum suppression
- Gas Withdrawal
- Small gas/liquid interface reduces corrosion
- Maximize Volume

Submerged Fixed Digester Cover

~ 8 Feet
Membrane Gasholder Covers

- A outer membrane
- B inner membrane
- C air flow system
- D belt system
- E anchor rail
- F non return valve
- G air blower
- H vacuum valve
- I over pressure valve
- J inspection window
- K ultrasonic
Digester Mixing Technologies Overview

- Pumped Recirculation Systems (JetMix™, Rotamix®)
- Draft Tube Mixers
- Gas 'Cannon' Mixing Systems
- Eimco LM™ (Linear Motion) Mixers
Mixing Nozzle Assemblies:
Glass-lined Ductile Iron (RotaMix®) or Hi-Chrome Iron (JetMix™) for abrasion resistance
- 3M™ Scotchkote™ coatings & 10-year Nozzle Warranties (RotaMix®)
- Rotatable Nozzle Assembly (Optional for JetMix™ System)

¬ CFD model of nozzle illustrating induced Flow patterns

RotaMix® Double Nozzle Assembly
Draft Tube Mixing Systems
Internal vs. External Mixers

For a 115-ft diameter digester tank manufacturers have proposed three different options:

- (5) Internal draft tube mixers (All three manufacturers)
- (5) External + (1) Internal Draft Tube Mixers (WesTech & Eimco)
- (5) External Draft Tube Mixers (OTI)
Gas ‘Cannon’ Mixing Systems

- DRAFT TUBE
- LANCE SEAL WELLS
- BAROMETRIC LOOP
- LANCES
- SPARGERS
JDV Turbomixer® Digester Mixers
Advantages:
- Much lower power required (approx. 12.5 Hp per tank)
- Lowest mixing capital cost

Disadvantages:
- Mixing effectiveness in question
- Unproven technology; three digester installations in operation since Dec. ‘03
- Bearing and gearbox failures?
LAWPCA Treatment Facility
LAWPCA with Digestion Facility
System Description

• Two concrete digesters
  – 65 feet diameter, 25 foot side wall depth
  – ~700,000 gallons each
  – Sized for 15 day SRT at maximum month flows and loads
  – Concrete, submerged fixed covers

• Pump mixing system

• Sludge recirculation through HEX for heating

• Digested sludge storage tank with membrane cover

• Outside waste acceptance – modify existing septage receiving station
Combined Heat and Power (CHP) System Selection

- Estimated biogas production = 170,000 ft³/day
- Cogeneration systems considered
  - Microturbines
  - Reciprocating Engines
- Engines selected over microturbines based on:
  - Higher efficiencies
  - Life cycle costs
  - Track record/number of operating installations
- Two – 230 kW engines (received $330,000 Efficiency Maine Grant)
CHP System Selection (Continued)

- **Electricity used on site:**
  - Provides all power for new digestion equipment
  - Reduces amount of power purchased from the utility for WW treatment

- **Heat Reclaimed from engines**
  - Provides heat for anaerobic digesters
  - Supplemental heat provided by dual fuel boilers (natural gas/biogas)
Biogas Treatment

- Biogas Treatment System
  - Foam separator and condensate/sediment removal traps
  - H$_2$S removal using Iron Sponge or SulfaTreat media
  - Moisture removal and gas boosting skid
  - Siloxane removal system to be added in the future, if necessary
Project Benefits

• Benefits that justify capital and O&M costs:
  – Reduces total solids by approximately 40%.
  – Eliminates the need to add lime to biosolids prior to land application.
  – Reduces biosolids odors, making land application program more acceptable.
• Eliminates transportation and tipping fees to haul biosolids to distant landfill.
• Produces biogas to generating electricity/heat for use on site.
• Potential for additional revenue from acceptance of outside wastes.