A Case Study for Retrofitting Anaerobic Digestion Facilities at the City of Waukesha

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Outline

- Project drivers at digestion facilities
- Improvements meet current and future needs
- Review of project sequence and construction
- System flexibility allows many operating strategies
- Initial data shows excellent performance
- Lessons learned provide value for WWTPs
Review of Anaerobic Digestion

Project Drivers

- Inefficient Mixing
- Equipment
- Aging Heating System
- Grit Accumulation
- Digester Foaming

Existing 90-ft dia Digesters and Control Room (1980)

Existing 55-ft dia Digesters and Control Room (1965)

Controls and Instrumentation

Inefficient Mixing Equipment

Aging Heating System
Selected Digestion Alternative Meets City’s Current and Future Needs

- Increased Gas Production
- Efficient Mixing Design
- Egg-Shaped Digester
- Minimal Maintenance
- Foam Detection and Control System
- Maximized Use of Existing Infrastructure
Waukesha CWP Digestion Upgrades

Dig. 2
- Steel cover to remain
- Variable depth (T-valve)
- Pump mix
- Spiral heat exchanger
- Foam control

New ESD (Dig. 1)
- Mixing / Recirc pumps
- Drain pump
- Heat exchanger
- Foam control

Centrate Storage
- Centrate Return pumps

Dig. 3
- Dual membrane cover
- Pump mix
- Spiral heat exchanger
- Foam control

Gas Handling
- Sediment traps
- Foam separator
- SS gas piping
- Relief valve
- Flare

Hot Water Boilers
- 100% and 50% units
Egg-Shaped Digester Advantages May Result in Best Alternative

- Facilities planning should include evaluation of alternatives to traditional “pancake” digesters:
  - Higher mixing efficiency
  - Greater gas production & foam control
  - Smaller footprint
Foaming Concerns Require Multiple Solutions
Grit Accumulation Impacts Plant Operations and Budget

Digester No. 3

Egg-Shaped Digester

Grit Accumulation
Space Constraints Required Unique Approach

Fox River

Main Site Roadway

Major Utilities
Egg-Shaped Digester Construction is First on Critical Path

- 1.1 million gallons
- 82 ft tall, 66 ft wide
- Spiral staircase from existing control building
- 4.5 ft thick foundation
- Pump mix with heat exchanger
- Internal draft tube
Existing Digester No. 4 Demolition
Egg-Shaped Digester Subgrade
Egg-Shaped Digester Foundation
Concrete Ring Wall
Steel Vessel
Dome Lift
Painting, Insulation, and Stairs
ESD Startup
Retrofit Digester No. 2

- New Gas Piping
- Insulation for Steel Cover
- New Mixing, Heating and Foam Control System
System Flexibility Allows Many Operating Strategies
Operation in Series Becomes Normal Sequence
• Reconfigure digesters for series operation (existing is parallel)
• TWAS and Primary Sludge pumped to Digester No. 1
• Flow out of Digester No. 1 by displacement to Digester No. 2 (steel cover)
• Flow out of Digester No. 2 through a telescoping valve to Digester No. 3 by gravity.
• Telescoping valve allows lowering of Digester No. 2 level for foam control.
Telescoping Valve

Telescoping Valve Determines Digester Level

Digester No. 2 Sludge Well
• Digested sludge pumped to the centrifuge through one of two pumps.
Initial Data Shows Excellent Performance

Solids Concentration (%)

Sample

0 0.5 1 1.5 2 2.5

1 2 3 4 5 6 7 8 9 10 11 12

Digester No. 1 Mixing Test

Digester No. 2 Mixing Test
Lessons Learned Provide Value for Future Projects
Coordination with CB&I

- Design requires close coordination with CB&I
  - Multiple design meetings
  - Coordination of scope (equipment, controls)
  - Discuss bidding strategy early (sole source concerns)
- Visit to project with CB&I digester

CB&I Egg-Shaped Digester (Grandville, MI)
Conclusion

• Improvements meet current and future needs
• System flexibility allows many operating strategies
• Initial data shows excellent performance
• Lessons learned provide value for WWTPs
Acknowledgements
Silo-Shaped Digesters

• Tall concrete cylinder
• Advantages
  ▪ Minimize footprint
  ▪ Efficient mixing
  ▪ Not proprietary
• Disadvantages
  ▪ More difficult to construct
Egg-Shaped Digesters

- Welded steel vessel
- Advantages
  - Better foam control
  - Minimize footprint
  - Efficient mixing
- Disadvantages
  - Only one supplier
Advantages of the selected alternative

- Makes maximum use of existing digestion infrastructure.
- Relatively low cost with only one new digester.
- Relatively low maintenance cost with only two digesters requiring routine maintenance (excluding egg-shaped digester).
- Relatively low energy cost for mixing (one egg-shaped and one conventional digester).
- Improved foam management.
- Can be configured for co-digestion of high strength wastes in the future – gas production.
Example - Waukesha WWTP

- Digestion improvement alternatives

- Refurbish Existing Digesters
- One new conventional digester
- One New Egg-Shaped Digester
- Two new conventional digesters
- Two new egg-shaped digesters
- Two silo-shaped digesters
Review of Project Sequence and Construction
Retrofitting Existing Infrastructure Provides Cost Savings

Digester No. 1 Converted to Gas Holder/Fill & Draw Digester

Conversion of 1960s Digester to Centrate Storage

Digester No. 2 Maintained as Active Digester