Energy Efficiency and Incentive Programs for Wastewater Facilities

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Agenda

• Energy Consumption in WWTP
• Energy Efficiency Opportunities for WWTP
• Incentive Programs for Public Wastewater Facilities
Energy Consumption in WWTP
Energy Consumption in WWTP

• Providing safe drinking water and reliable wastewater services requires a substantial amount of energy

• Enormous potential to reduce energy use without compromising quality standards

• Shorter paybacks than industrial counterparts due to longer hours of operation

Wastewater Industry Energy Consumption

• 3% to 4% of U.S. energy consumption is used for drinking water and wastewater services

• 35% of a typical municipality energy budget is for water and waste water treatment

• 25-40% of a typical WWTP operating budget spent on electricity
Energy Consumption Breakdown in WWTP
Energy Efficiency Opportunities for WWTP
Energy Efficiency Opportunities for WWTP

- Aeration
- Wastewater Pumping
- Anaerobic digestion
- Lighting and Buildings
Energy Efficiency Opportunities for WWTP

- Aeration
- Wastewater Pumping
- Anaerobic digestion
- Lighting and Buildings
Aeration

• Optimize Aeration System

<table>
<thead>
<tr>
<th></th>
<th>Transfer Rate (#O₂/HP•hr)</th>
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</thead>
<tbody>
<tr>
<td>Coarse Air Bubble</td>
<td>1.5</td>
</tr>
<tr>
<td>Fine Air Bubble</td>
<td>3.3</td>
</tr>
<tr>
<td>Mechanical Aeration</td>
<td>3.9</td>
</tr>
<tr>
<td>Fine Air Bubble + High Efficiency Blowers + VFD</td>
<td>6.6</td>
</tr>
</tbody>
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• 20-75% typical energy savings of unit of process

• 1-5 years typical payback
Bubble Types

Fine Bubble

Coarse Bubble
Aeration

• Variable Blower air Flow Rate
  • Blower Control: Provide the Correct Air Flow
  • Control Technique Varies With Type of Blower
    • Positive Displacement Blowers with VFD
    • Multistage Centrifugal Blowers with VFD or Inlet valve throttling
    • Single Stage Centrifugal Blower inlet guide-controlled
    • Turbo blower with VFD
Aeration

• Variable Blower air Flow Rate
  • 15-50% typical energy savings of unit of process
  • <3 years typical payback
• Applies to all aeration systems
  • Activated Sludge
  • Aerobic Digestion
  • Channel Aeration
  • Post Aeration
  • Aerated Grid
Aeration

- Automatic Dissolved Oxygen Control
  - Monitor and maintain the dissolved oxygen concentration level at a preset control point by varying the air flow rate
  - Variable Flow may be provided Through the use of VFDs
  - 20-50% typical energy savings of unit of process
  - 2-3 years typical payback
Aeration

- Automatic Dissolved Oxygen Control
Aeration

• Blower Technology Options
  • Blower Technology Continually Evolving
  • Blowers are increasingly Energy-Efficient
  • Things to be considered
    • INITIAL COST
    • EFFICIENCY
    • TURN-DOWN CAPABILITY
    • REPAIR & MAINTENANCE
  • 10-25% typical energy savings of unit of process
  • 1-7 years typical payback
Aeration

- **Blower Technology Options**
  - Positive Displacement Rotary lobe blowers:
    - Low initial cost
    - Low Efficiency
    - High Turn down Ratio
    - Moderate to Considerable Repair/Maintenance
Aeration

• Blower Technology Options
  • Turbo blowers
    • Higher initial Cost
    • Higher efficiency
    • Limited Turn Down Ratio
    • Minimal Repair/Maintenance
Aeration

• Blower Technology Options

  • Positive Displacement Hybrid rotary lobe-screw blowers
    • High initial Cost (Lower than Turbo Blowers)
    • High efficiency (Lower than Turbo Blowers)
    • High Turn Down Ratio (Comparable to Rotary Lobes)
    • Moderate to Considerable Repair/Maintenance
Energy Efficiency Opportunities for WWTP

- Aeration
- Wastewater Pumping
- Anaerobic digestion
- Lighting and Buildings
Wastewater Pumping

• Install High efficiency Motors and Pumps
  • Typical Max. Eff. Pump: 70%
  • Typical Max. Eff. Motor: 90%
  • Worst Case Pump: 40%
  • Worst Case Motor: 85%
  • 5-10% typical energy savings of unit of process
  • <2 years typical payback
Wastewater Pumping

• Variable Frequency Drive Applications
  • VFDs Match Motor Output Speed To specific Load
  • Can Replace Throttling Valves
  • 10-40% typical energy savings of unit of process
  • 0.5-5 years typical payback
  • Reduce Peak Demand Charges
Energy Efficiency Opportunities for WWTP

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Anaerobic digestion
• Bio-solid Mixing Options
  • Anaerobic Digestion is Highly Dependent Upon Effective Sludge Mixing
  • Could Represent Approximately 10-15% the Energy Use in a Wastewater Treatment Facility
  • Three Types:
    • Gas Recirculation
    • Pumped
    • Mechanical
Anaerobic digestion

- Bio-solid Mixing Options - Vertical Linear motion mixing
  - Use Vertically Oscillating Disc
  - 50-90% less power than traditional methods
  - Variable Payback (2-16 Years)
Anaerobic digestion

Bio-solid Mixing Options - Jet mixing

• One or more internally or externally mounted pumps deliver a recirculated flow into a series of nozzles.
Anaerobic digestion

- Bio-solid Mixing Options - Jet mixing
  - Power Savings of up to 50% or More
  - Reduced maintenance costs
  - Significant Reduction in Tank Cleaning Costs
Energy Efficiency Opportunities for WWTP

- Aeration
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Lighting and Buildings

• High-Efficiency Lighting and Advanced Controls
  • Light Emitting Diode (LED)
  • Energy-Efficient Fluorescent Lighting
  • Multi-Level Lighting controlled by
    • Motion
    • Ambient Day Light
    • Timers
    • Combination of above
  • 10-30% typical energy savings of unit of process
  • <4 years typical payback
Lighting and Buildings

• Existing HVAC Systems Replacement or Recommissioning
  
  • Recommissioning: Overall evaluation and adjustment of the system to ensure it is operating properly and to design conditions
  
  • Several opportunities for replacement: Variable Refrigerant Flow (VRF) Systems, Condensing Boilers, Energy-Efficient Unitary Systems, Energy Star Windows Units, etc
  
  • Variable Payback and Energy Savings:
    
      • Recommissioning can provide savings in operational, maintenance and utility cost, and energy savings of 10-20%
    
      • Simple Payback depends on size and condition of the existing equipment
    
      • 4-8 years for replacement projects
Lighting and Buildings

• Install VFD Control on Air Compressors
  • Rotary Screw Air Compressor with Inlet Modulation with unloading is Highly Inefficient, Requires About 20% of the Load in Unloading Mode
  • VFDs on a Rotary Screw Air Compressor Widely Implemented by the Industry
  • Save energy Especially in Part Load Operation
  • Payback and Energy Savings Depend on the Operating Hours and Size of the Compressor
  • Leak repair, reduce system pressure set point, tank storage with flow controller
Incentive Programs for Wastewater Facilities
Ameren Illinois Energy Efficiency Programs

• Public Wastewater facilities as part of the public sector can take advantage of a number of cash incentives to improve the energy efficiency of the plant and reduce energy use.
  
  • Two primary types of incentives
  • Standard (prescriptive) – pre-determined incentive
  • Custom – incentive based on energy saved
Ameren Illinois Energy Efficiency Programs

- Standard Incentive (prescriptive measures)
  - Lighting (Interior and Exterior LED, Lighting Controls, LED Exit Signs)
  - HVAC (Water Heaters (electric/gas), Chillers, Furnace Replacements, Boiler Replacements, Programmable and Advanced (Smart) Thermostats, Demand Controlled Ventilation)
  - Variable Frequency Drive
  - Specialty Equipment (VFDs Controlling Air Compressor Motors)
Ameren Illinois Energy Efficiency Programs

• Custom Projects
  • Any other projects that reduce energy consumption, including unique projects at WWTP
  • $0.08/kWh saved annually (non-lighting)
  • $0.07/kWh saved annually (lighting)
  • $1.20 therm saved annually
  • Up to 60% of the Project Cost
  • All custom projects require pre-approval
Ameren Illinois Energy Efficiency Programs

- Other Incentives
  - New Construction
  - Retro Commissioning
  - Feasibility Study
  - Metering and Monitoring
  - Pre-approval required for these project types
Other potential funding sources for WWT projects

• Environmental Protection Agency (IEPA)

http://www.epa.illinois.gov/topics/grants-loans/state-revolving-fund/index

• Illinois Clean Energy Community Foundation (ICECF)

https://www.illinoiscleanenergy.org/energy-program/net-zero-energy-wastewater-treatment-plants

• United States Department of Agriculture (USDA)


• U.S. Department of Energy (DOE)

https://www.energy.gov/eere/amo/sep-water-wastewater-pilot-project
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