Energy Efficiency Modifications

Small Blowers

D.O. Control and VFD’s

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Kiel
Wastewater Utility
Kiel Wastewater Utility Treatment Facility Aerated Systems

- Aerated Grit Chamber
- Channel Aeration
- Aeration Basins
- Aerated Sludge Holding Tanks
- Post Aeration Basin
Aerated Grit Chamber

12ft x 12 ft x14 ft SWD

Existing
-60 hp positive displacement (pd) blower shared with aerated sludge holding tanks and post aeration

Required
- 75 cfm @ 7.5 psi = 7.5 hp
Channel Aeration Blower
Channel Aeration

Existing
- 30 hp PD blower
- Channel sizes are (2) D 5’ x W 3’ x L 98’
  (1) D 4’ x W 3’ x L 54’

Required
- 5 cfm/ft for 250ft of channel length
- 1250 cfm @ 3.5 psi = 30hp
Aeration Tank Blower
Aeration Basin

Existing
-(3) 100hp PD blowers run manually 24/7

- Blowers operating at capacity

-D.O. 10mg/l 80% of the time

-10 Aeration Tanks with ceramic fine bubble diffusers set in a full floor coverage arrangement

-15 year D.O. meters

-Operated as complete mix

-14ft SWD of basins
2006 WWTF Influent Average Monthly Loading lbs/day BOD
Additional Info on Aeration Basins

*Influent to Aeration Basins

Daily BOD lbs/day
1,072 lbs/day to 10,087 lbs/day
Average 2,985 lbs/day

(this reflects 25% reduction of influent BOD based on facility data from primary clarifier effluent)

Flow
.67mgd to 1.33mgd
Required Aeration for Loading
- 14ft SWD = 7.5 psi

- minimum mixing air flow 2460 cfm for full floor coverage arrangement @ 0.125 cfm/sqft

- Code mixing 5510 cfm

- D.O. 2 mg/l

Average Loading
(2,985 lbs/day BOD) \times (1.2 \text{ lbs OXY/lbs BOD}) \times (\text{day}/1440) \times (\text{cf air}/0.0158 \text{ lbs of Oxy}) \times (1/0.18 \text{ efficiency}) = 875 \text{ cfm}

Low Loading
(1,075 \text{ lbs/day BOD}) / (2,985 \text{ lbs/day BOD}) \times 875 \text{ cfm} = 315 \text{ cfm}

High Loading
(10,090 \text{ lbs/day BOD}) / (2,985 \text{ lbs/day BOD}) \times 875 \text{ cfm} = 2960 \text{ cfm}
Secondary Notes on Aeration Basins

- 2.5 days (60hrs) detention time
- Most design manuals 8-12hrs
- reasonable time for industrial loading 12-18hrs
- Facility can take off-line individual basins or one train of basin capacity (facility has 3 trains of basins).

Reduction in Detention Time

- Reduce aeration basins on-line to achieve 18hrs detention

- \( \frac{18\text{hrs}}{60\text{hrs}} = 30 \text{ percent} \)

- 30 percent would lower air requirements including minimum air required for mixing.

Average Loading reflecting 30% reduction = 1640cfm

Organic requirement still 875cfm
Aerated Sludge Storage, Grit and Post Aeration Blower
Aerated Sludge Holding Tanks

-Waste Activated Sludge is aerated to lower VSS, then decanted and processed

Existing
-60hp PD blower per tank
-Post Aeration and Aerated Grit share blowers

Required
-233cfm - 465cfm @ 9.5psi = 29hp
Post Aeration Basin

Existing
-60hp PD blower shared with Aeration Sludge Storage Tank and Aerated Grit Chamber

Required
-Maintain 6mg/l D.O. at discharge

127cfm @ 5psi
Estimated Energy Consumption

(2) 60hp Aerated Grit, Post Aeration, Aerated Sludge Holding Tank
   * 89.5kW x 8760hrs/yr = 784,020kWh/yr

30hp for Channel Aeration
   * 22.4kW x 8760hrs/yr = 196,224kWh/yr

(3) 100hp Aeration Basins
   * 224.2kW x 8760hrs/yr = 1,963,992kWh/yr

Total Energy Savings  = 2,944,236kWh/yr
Actual Energy Cost

• 2006 3,343,604 kWh

  88% Aeration = 2,944,236 kWh/yr

• 0.06 $/kWh

$176,650 year for plant aeration
Modifications Suggested

- Aerated Grit Chamber 75cfm @ 7.5psi = 4hp
- Channel Aeration 1250cfm @ 3.5psi = 23hp
- Aeration Basins 2460cfm @ 7.5psi = 100hp
- Aerated Sludge Storage Tanks 233-465cfm @ 9.5psi = 23hp
- Post Aeration Basins 120cfm @ 5psi = 4hp

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154hp
Forecast Energy Savings

- \(154\text{hp} \times 0.746\text{kW/hp} \times 8760\text{hr/yr} = 115\text{kW} \times 8760\text{hrs/yr}\)  
  \(= 1,007,400\text{kWh/yr}\)

\(2,944,236\text{kWh/yr} - 1,007,400\text{kWh/yr} = 1,986,836\text{kWh/yr}\)

- \(1,986,836\text{kWh/yr} \times 0.06\$/\text{kWh} = 119,210\$\text{/yr}\)

Cost for Changes Estimated

- $314,000 blower modifications

Simple Payback 2.6yrs
Kiel Wastewater Utility

- Aeration System Energy Efficiency Study
  - based on Focus on Energy
  - estimated construction cost for the viable option
  - looked at non-monetary advantages and disadvantages
  - process changes could be made for greater savings
Aeration Basins
- change from complete mix to plug flow
- one large blower with a VFD

Least cost on present worth basis
- New D.O. meters and VFD’s

Channel Aeration
- mixer vs. aeration
- fine bubble diffuser

Least cost on present worth basis
- 30hp PD blower on VFD
Post Aeration Tank
- cascade vs. aeration
- fine bubble vs. coarse

Least cost on present worth basis
- 7.5 hp PD blower with D.O. control

Aerated Grit Chamber
- vortex vs. aerated

Least cost on present worth basis
- leave on 60hp blowers

Plant Staff Change
- 7.5hp post aeration, link aerated grit and ramp up drive when pumping.
Aerated Sludge Storage Tanks

- coarse vs. fine bubble
- mixers vs. aeration
- single batch tank

Least cost on present worth basis
- 40hp PD blower per tank
- level driven VFD
Kiel Wastewater Utility Chose to Implement

- (2) 150hp PD blowers direct driven and D.O. controlled VFD’s on Aeration Basins
- 7.5hp PD blower on Aerated Grit and Post Aeration Tank D.O. controlled VFD with relay to set speed when grit is pumping
- (2) 40hp PD blowers Aerated Sludge Holding Tanks
- 40hp Aerated Channel PD blower on VFD for future
Construction

- Plans and specs for DNR approval
- Plant personal install
- Direct purchase of equipment through competitive quotes - direct drive vs. box vs. high speed
- Purchase Orders out July 2008
- Blower Delivered December and January 2009
- Savings in construction purchased a new plc and touch panel for the operation of blowers and processes.
WWTF BOD lbs/day Average Loading vs. Power kWh/yr
Power kWh/yr vs. Actual Cost
Future Actions

- May 2006 4187lbs/day BOD @ 282,240kWh
- June 2009 4246lbs/day BOD @ 203,520kWh
- Sept. 2009 5090lbs/day BOD @ 177,600kWh
- May 2010 5730lbs/day BOD @ 226,560kWh

- Operational
  - D.O. 1.5-2.0 mg/l
  - Filamentous

- Next step on the system will be testing to see if a correction can be made to control the filamentous and run in the 1.5mg/l D.O.
Questions?

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