Energy Efficiency Modifications

Small Blowers
D.O. Control and VFD's

Joe Cantwell
Focus on Energy
Kris August
Kiel Wastewater Utility

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

- **5cfm/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

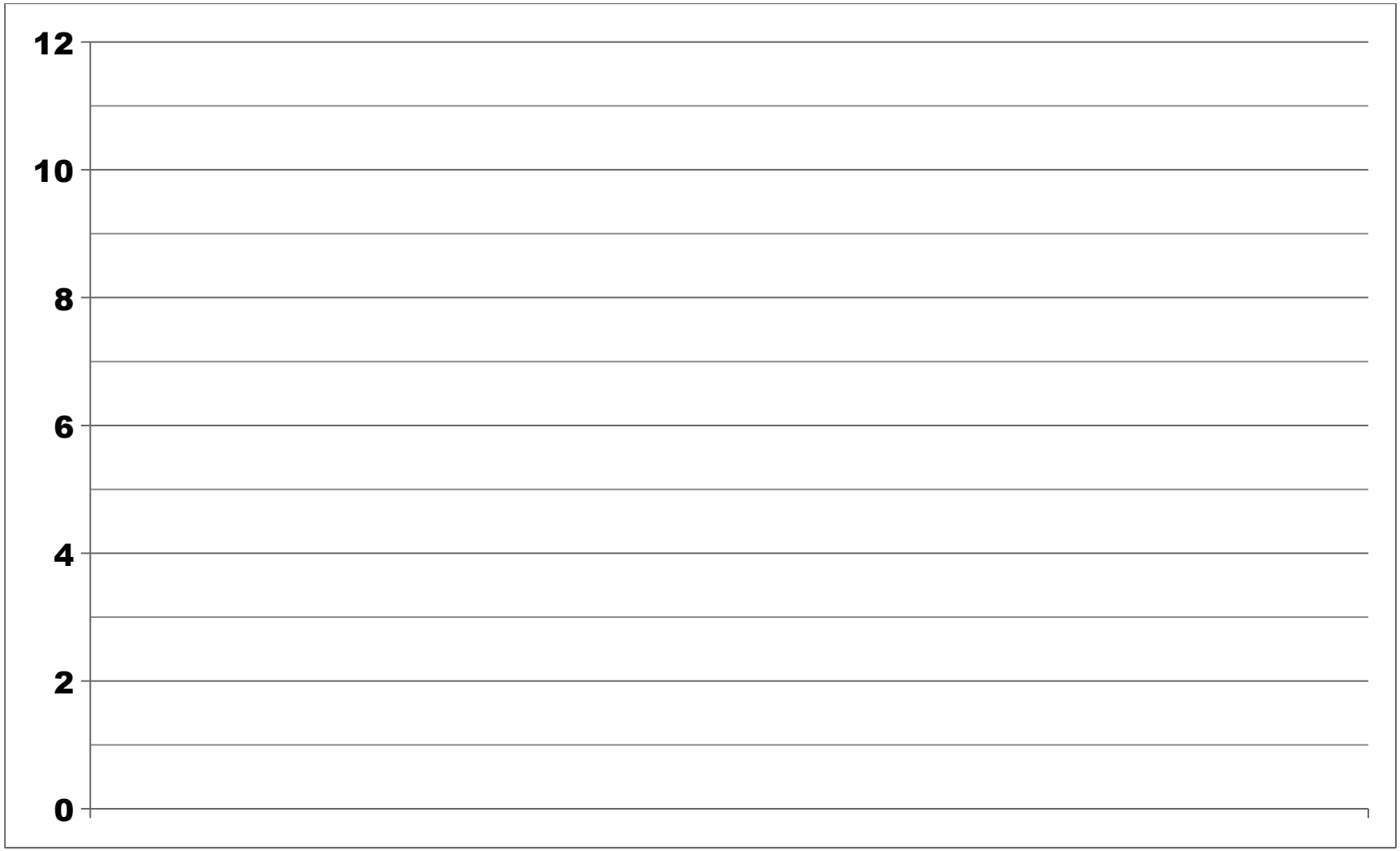
-10 Aeration Tanks with ceramic fine bubble diffusers set in a full floor coverage arrangement

- **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 2460cfm for full floor coverage arrangement @ 0.125 cfm/sqft

- Code mixing 5510cfm

-D.O. 2mg/l

Average Loading
(2,985lbs/day BOD) x (1.2lbs OXY/lbs BOD) x (day/1440) x (cf air/0..0158lbs of Oxy) x(1/0.18 efficiency) = 875cfm

Low Loading
(1,075lbs/day BOD) /(2,985lbs/day BOD) x (875cfm) = 315cfm

High Loading
(10,090lbs/day BOD) / (2,985lbs/day BOD) x 875cfm = 2960cfm

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

- (18hrs/60hrs) = 30 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 3,343,604kWh

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

154hp

Forecast Energy Savings

- 154hp x 0.746kW/hp x 8760hr/yr = 115kW x 8760hrs/yr = 1,007,400kWh/yr

2,944,236kWh/yr – 1,007,400kWh/yr = 1,986,836kWh/yr

- 1,986,836kWh/yr x 0.06$/kWh = 119,210 $/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.


ROBOT


ROBUSCHI
ROBOX


EXIT
ROBUSCHI
ROBOX


3
4


TRY
PA. 19355


4
WARNING


DSM101
SOUND LEVEL METER
94.5
RNG


DSM101
SOUND LEVEL METER
77.1
RNG

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?

Joe Cantwell
Focus on Energy
(262)786-8221
JOSEPH.C.CANTWELL@saic.com

Kris August
Kiel Wastewater Utility
(920)894-2133
kielwwtp@yahoo.com