Energy Efficiency & Wastewater Optimization

Supporting Agency Climate Initiatives
&
Making a Visible Difference

Walter Higgins
Office of Infrastructure & Assistance
Water Protection Division
EPA Region 3

$$ FACTOID $$

- Providing Drinking Water and Wastewater Treatment:
  - 3-4 percent of national electricity consumption
  - 56 billion kilowatts (kW)
  - $4 billion
- PWS & STPs most energy-intensive facilities operated by local governments

Energy accounts for 35 percent of energy used by municipalities!

A lot of $$!!

2012-2013 PA

- Train staff
- Partner with PADEP
- Conduct Training for W&WW Operators

2014 DE

- Partner with DNREC, DHSS, DSEU
- Conduct Training for W&WW Operators
- Conduct Several Energy Assessments

2015-2016 MD

- Partner with MDE
- Conduct Training for WW Operators
- Develop Energy Course training material anywhere
- Optimization – Nutrient Removal

2016-2017 VA

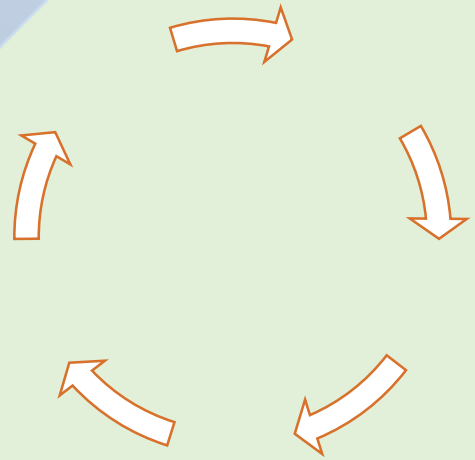
- Partner with VADEQ
- Conduct Training for WW Operators
- Conduct 10 Energy Audits
- Optimization – Nutrient Removal

2017 WV

- Partner with WVDEP
- Conduct Training for WW Operators
- Conduct 10 Energy Audits
- Optimization – Nutrient Removal

Energy Training:

- Understand Your Electric Bill
- Energy Saving Projects and Case Studies
- Math Behind the Savings
- DIY Energy Audit



Partners

- EPA National Sustainable Infrastructure Team
- DOE/Industrial Assessment Centers
- Rural Water Associations
- States' Infrastructure Funding Agency
- States' Technical Assistance Providers
- State Water/Environment Assoc.
- Engineering Firms
- Technology/Equipment Reps
- Network of Water Utility Staff and Management

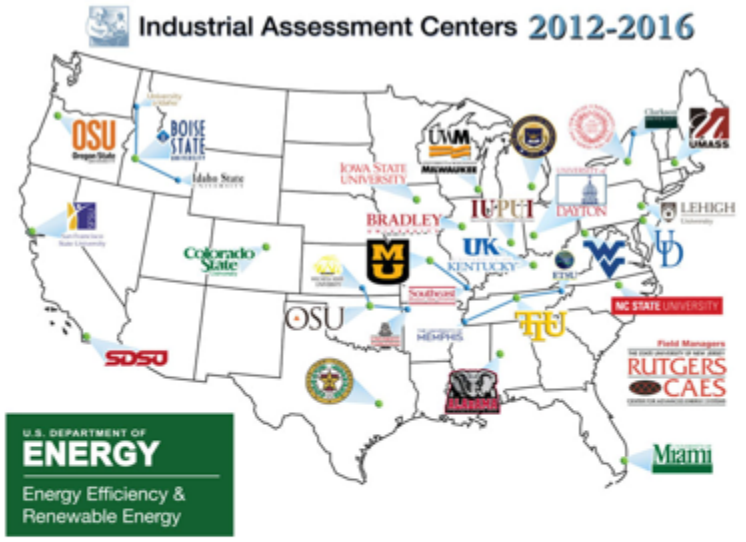
U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Industrial Assessment Centers

ADVANCED MANUFACTURING OFFICE
TECHNICAL ASSISTANCE ACTIVITIES
March 2015

Identifying Energy Savings in Water and Wastewater Plants

Since 1976, the Industrial Assessment Centers (IACs), administered by the U.S. Department of Energy, have supported small and medium-sized American manufacturers, to reduce energy use and increase their productivity and competitiveness. DOE is now offering up to 50 assessments per year to industrial or municipal water and wastewater plants. The 24 IACs, located at premier engineering universities around the country (see below), send faculty and engineering students to local plants to provide no-cost assessments of energy use, process performance, and waste and water flows. Under the direction of experienced professors, IAC engineering students visit plants to analyze energy bills and various energy and water systems including pumps, motors, compressed air, lighting, process heat, steam, and CHP. The IACs then follow up with written energy-saving and productivity improvement recommendations, with estimates of related costs and payback periods.



The IACs offer expertise and access to information and resources for energy efficiency, energy recovery, and energy management. For IAC contact information or to determine if you are eligible for an assessment, see the following link:

http://www.energy.gov/eere/amo/locations-industrial-assessment-centers

IAC Water Experience

- 30 plants have received assessments from their local IAC, with plant sizes ranging from 1.6 MGD – 115 MGD.
- Annual utility bills range from $107,361 to $5,009,337.
- Per plant potential cost savings for increasing energy efficiency, reducing waste, and improving productivity, averages $232,000.
- Identified savings average $31,000 per MGD of flow.

Assessment Sign Up

If your facility is a water or wastewater plant meeting these general criteria:

- Water treatment plant >5 MGD
- Wastewater treatment plant >2 MGD
- Annual energy bills between $250,000 and $2.5 million

Then contact your closest IAC to see if you are eligible for a no-cost assessment.

For additional IAC information

DOE's IAC Program Lead
John Smegal
U.S. Department of Energy
(202) 287-6225
John.Smegal@ee.doe.gov

Communication

- 3 Articles Published
- Blogs and Salients
- Website
- WPD Progress Stories
- Local Gov’t Newsletters
- SRF All-State Meeting Presentation
- Trainings and Presentations

TOO MUCH AIR!

Wastewater treatment plant operators are saving energy, using fewer chemicals, and gaining better control of their activated sludge process by optimizing their aeration systems, including aerobic digestion.

This article will discuss the effects of over-aeration, ways to better control your aeration systems to save energy and chemicals, and end with a few success stories.

The aeration zones in the activated sludge process are one of the most critical processes in a wastewater treatment plant (WWTP). For purposes of this discussion, the term 'activated sludge' is the biological components of the WWTP including secondary treatment and nitrogen and phosphorus removal. These zones create an environment full of dissolved oxygen that promotes growth of certain organisms that break down the organics (secondary treatment) and ammonia (nitrification). The oxygen is needed for these organisms to breathe and reproduce, just like us humans.

The question is: is it possible to over-aerate your activated sludge process? There are many operators and wastewater professionals that would say, 'No. The more the better!' This is a conservative and very common answer. But the real answer is: 'yes,' in many cases you can provide more oxygen than truly needed.

TOO MUCH IS NOT GOOD

Over-aeration is wasteful from an energy efficiency standpoint and it can negatively affect process performance.

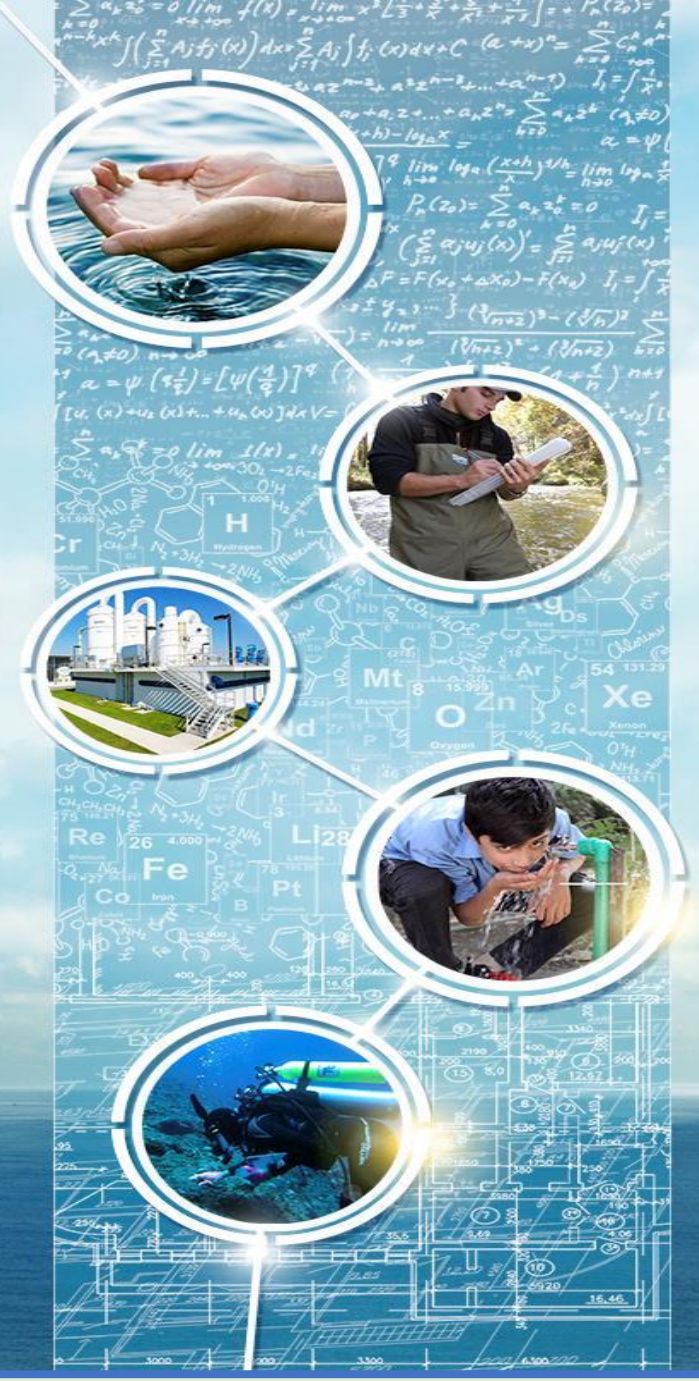
Energy is one of the highest costs at a WWTP and aeration is usually the number one energy consumer. That being said, this is a great area to achieve energy and cost savings with the customers and the local communities benefitting.

Most WWTPs operate their aeration zones and aerobic digesters at 1-3 mg/l dissolved oxygen (DO). Anything over 3 mg/l may be a waste of DO and energy. One may think that aerating at 1 or 2 mg/l over the DO setpoint is not much of a waste. Actually, the energy (horsepower) required for that incremental change in DO is significant.

Over-aeration can also cause operational problems. Operators love a mixed liquor that settles well. The mixed liquor settles well when the microorganisms (bugs) in the aeration tank excrete a sticky film around their cells as their food gets depleted. The aeration system keeps the bugs in suspension, allows them to collide with each other, and ultimately stick together, like Velcro®, forming a floc. The floc exhibits a snowball effect and, by the time it reaches the secondary clarifier, it's denser than water and settles. Over-aeration can break apart this floc, which should be

"Minimum acceptable DO (dissolved oxygen) concentration should range between 2 and 3 mg/l (for nitrification). Nitrification appears to be inhibited when the oxygen concentration is lower than 1 mg/l."

Operation of Municipal Wastewater Treatment Plants, WEF MOP 11, p507



TETRA TECH

Case Studies on Implementing Low-Cost Modifications to Improve Nutrient Reduction at Wastewater Treatment Plants

November 5, 2015

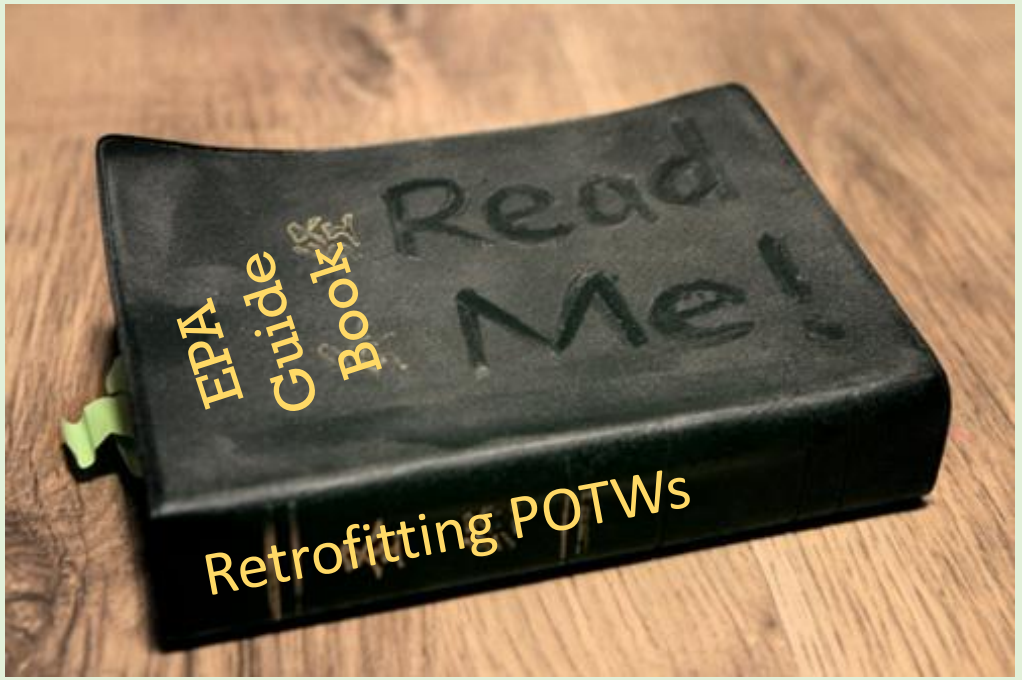
Victor D'Amato

Not Necessarily New

- Retrofitting POTWs (EPA 1989)

- Optimization Guidance Manual for Sewage Works (WEF of Ontario)

- Case Studies on Implementing Low-cost Modification to Improve POTW Nutrient Reduction-DRAFT (EPA 2015)



Enhanced Nutrient Removal

- Generally, this is outside the scope of optimization.

Purpose of Optimization

- Improve effluent quality
  - Better removal efficiencies of nutrients, etc.
- Minimize costs of operations
  - Save energy, chemicals, man power
- Alternatives to capital upgrades
  - Do more with what you have
  - Remove additional pollutants, i.e. TN and TP

Operator Training Required

- Most optimization projects fail due to a lack of training operators to maintain new processes.
- Requires basic training on new processes.
- Needs to develop a new process control strategy based on the facility.
- Several weeks of follow-up to insure correct decisions are made.

Making a Visible Difference!

Energy Efficiency

State	Name	Project Description	Projected Savings (kWh)	Projected Savings	Project Implemented	Proj Ton CO2 Reduced	Partner	FY
DE	Sussex County Regional WWTF	on/off aeration, install VFD on blowers	700,000	$ 56,000	No	532	DNREC	2014
PA	Central DE County Authority	Larger force main	262,966	$ 21,037	No	200	NA	2014
PA	Exeter Twp	on/off aeration	150,000	$ 12,000	Yes	114	PADEP	2014
PA	Halstead Great Bend JMA	on/off aeration digester	54,000	$ 4,320	Yes	41	PADEP	2014
PA	Oley Township	Install new blower and control system.	90,000	$ 7,200	Yes	68	PADEP	2014
PA	Pottstown WWTP	on/off aeration	269,300	$ 21,544	Yes	205	PADEP	2014
PA	Schuylkill Haven	on/off aeration, reduce RAS pump hp	162,500	$ 13,000	No	123	NA	2014
PA	Upper Saucon Twp	on/off aeration & DO control	150,000	$ 12,000	No	114	NA	2014
DE	Selbyville, Town of	On/off aeration in digester lagoons.	480,000	$ 38,400	Yes	365	DNREC	2015
PA	Halstead Great Bend JMA	Lower DO Setpoint 0.5mg	22,500	$ 1,800	Yes	17	PADEP	2015
PA	Dillsburg SA	reduce aeration in digester	54,750	$ 4,380	No	42	PADEP	2015
PA	Womelsdorf	Install new blower and control system.	15,000	$ 1,200	NA	11	PADEP	2015
PA	Williamsport	NA - Just initial visit	-	$ -	NA	0	NA	2015
MD	Delmar	Timer On Digester Blowers	179,040	$ 14,323	No	136	MCET	2015
MD	Cumberland	Numerous	1,244,706	$ 105,800	No	946	IAC	2015
PA	Broadhead Creek	NA - Just initial visit	-	$ -	No	0	PADEP	2015
PA	Morrisville	Numerous	431,279	$ 37,090	NA	328	IAC	2015
MD	Queen Anne County	Reduce aeration time	100,000	$ 8,000	Yes	76	MCET	2015
PA	Montrose	on/off aeration in digester	150,000	$ 12,000	NA	114	NA	2016
PA	Exeter Township	Upgraded aeration control to MOV	640,530	$ 51,242	Yes	448	PADEP	2016
PA	Gifford Pinchot State Park WWTP	On/Off aeration in the mainstream.	40,844	$ 3,268	No	29	PADEP	2016
PA	Lebanon Valley MHP WWTP	On/Off aeration in the mainstream	8,168	$ 653	No	6	PADEP	2016
PA	Millersburg Borough Area Authority	On/Off Aeration in mainstream.	245,000	$ 19,600	No	172	PADEP	2016
PA	White Run Regional MA	On/Off aeration in the digesters.	41,000	$ 3,280	No	29	PADEP	2016
PA	Williamstown Borough Authority	NA - Just initial visit	-	$ -	0	0	PADEP	2016
PA	Wrightsville Borough Municipal Aut	On/Off digester aeration.	57,180	$ 4,574	No	40	PADEP	2016
			4,516,041	$ 370,094		3,432		

R3 WW Optimization Team Accomplishments

Wastewater Optimization

State	Name	Project Description	Potential Lbs Nutrient Reduced	# Operators Trained	Partner	FY
PA	Abington	SE PA Phosphorus Optimization (Site visit and report)	TP 9608 (1)		R3 TMDL & PADEP	2015
PA	Ambler	SE PA Phosphorus Optimization (Site visit and report)	(2)		R3 TMDL & PADEP	2015
PA	Upper Dublin	SE PA Phosphorus Optimization (Site visit and report)	TP 1022 (1)		R3 TMDL & PADEP	2015
PA	Upper Gwynedd	SE PA Phosphorus Optimization (Site visit and report)	(2)		R3 TMDL & PADEP	2015
PA	West Goshen	SE PA Phosphorus Optimization (Site visit and report)	(3)		R3 TMDL & PADEP	2015
PA	Goose Creek	SE PA Phosphorus Optimization (Site visit and report)	TP 4455 (1)		R3 TMDL & PADEP	2015
PA	Bryn Athyn	Continuous assistance with TN removal to meet new permit	TN 6000	3	PADEP	2015
PA	Salisbury	Compliance Assistance (NH4 violations)		1	PADEP	2015
PA	Hastead Great Bend JMA	Continued training on process control and optimization.		2	PADEP	2015
PA	Montrose	Continued training on process control and optimization.		12	NA	2015
PA	Marietta-Dongal	Optimization. Discussed Process Control		2	PADEP	2015
PA	Morrisville	Continued training on process control and optimization.		2	PADEP	2015

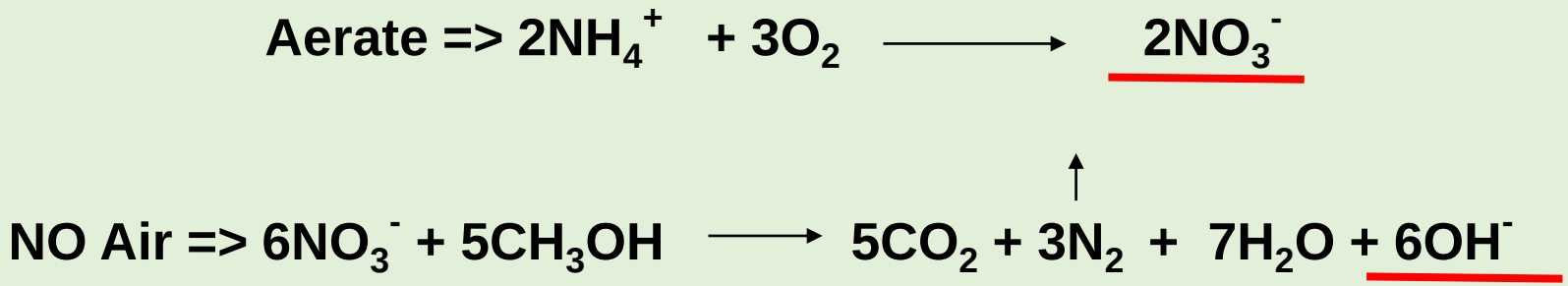
1	Assuming 0.5mg/l is a reliable level of treatment with chemical addition.
2	2014 DMRs show levels achieved below 0.5mg/l
3	WG has experimented with chemical removal with minimal success.

Best Candidates for Optimization

- Extended aeration activated sludge to BNR levels.
- When actual flows are significantly less than design.
- Potential exists to add new zones to aeration tanks.
- Aeration systems are generally over designed.
- Sufficient nutrients in the influent.

Nitrogen Removal – good potential

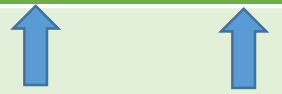
- Requirements to remove ammonia is generally well known.
- Going next step to remove total nitrogen is not well understood by the operators.



Phosphorus

- Chemical addition has been around for a long time and the principles are understood by the operators
- Fine tuning chemical addition is an art.
- Biological removal is not well understood by the operators.
  - I.e., VFA's role, required ORP/O_2 levels,
- Side-stream impacts makes things complicated.
  - Aerobic digestions – shut off to decant, release P
  - Anaerobic digestions – release P

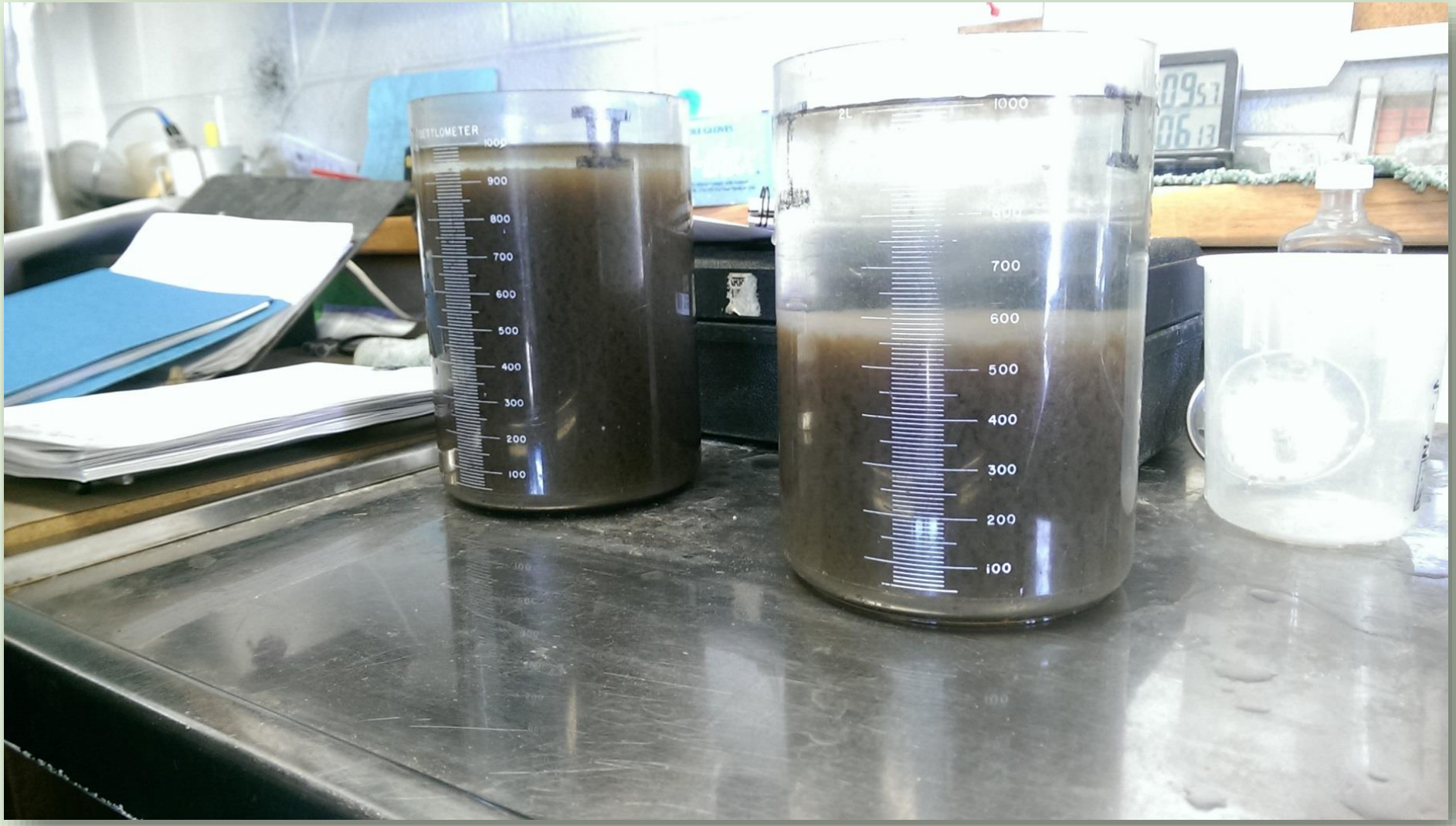
BUGS eat BUGS + O_2 => CO_2 + H_2O + PO_4 + NH_3 + …



Bryn Athyn

- Needed to meet a new Total Nitrogen limit of 10 mg/L.
- Plant is a small extended aeration facility.
- Actual flows is about half of the design with very low influent BOD.
- Past technical assistance shut off one of the two aeration tanks.
- New superintendent asked for help!

Too much sludge! Dilution test.



Before Baffle

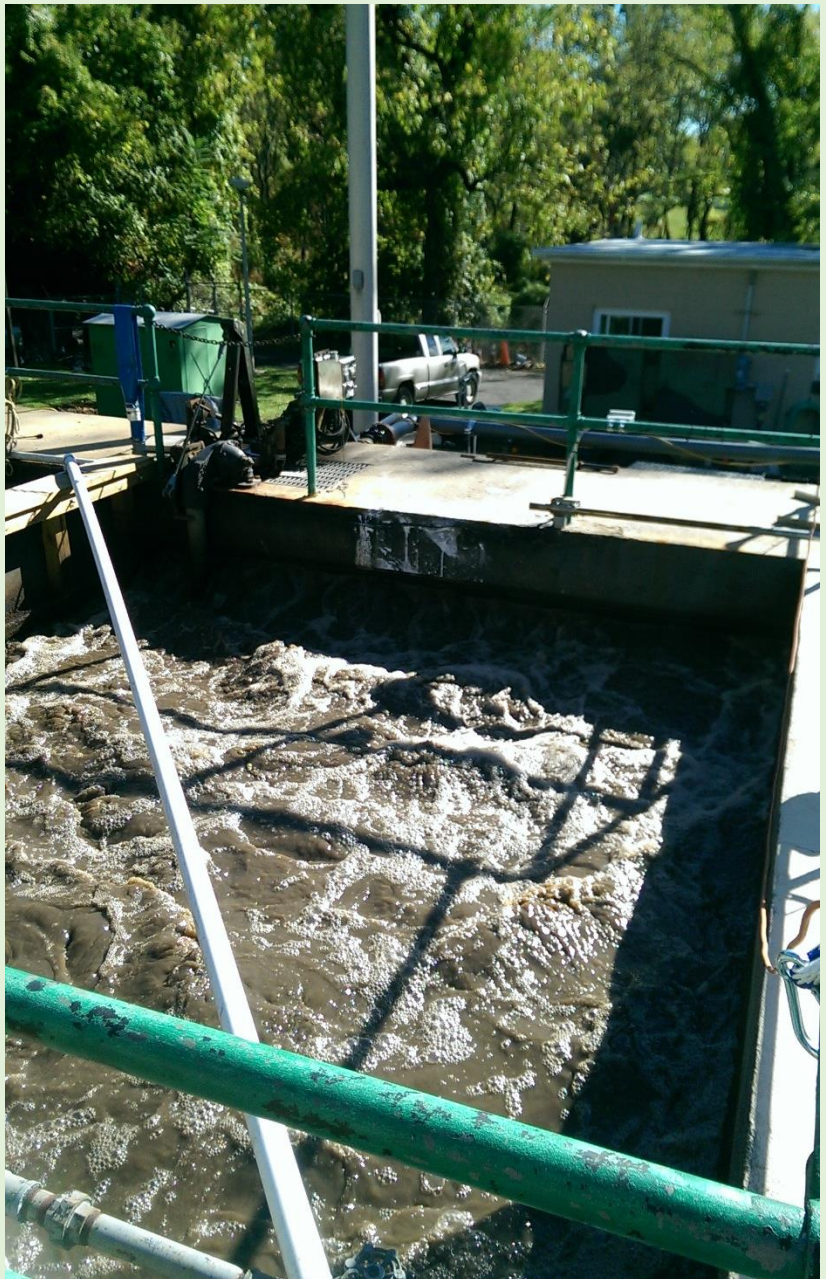
After Baffle: Create an Anoxic Reactor

With Internal RAS

No Air
ANOXIC

Air
OXIC

Clean Diffusers



Waste Sugar/Water Mix

Nitrate levels - Message (HTML)

FILE MESSAGE

Mon 8/3/2015 11:00 AM

Reid Heinrichs <reidh@brynathynboro.org>

Nitrate levels

To Neville, Marc; Matlin, Martin; Kern, Jim; Higgins, Walter; Burke, David; Glenn Gurney

You replied to this message on 8/4/2015 7:39 AM.

Message 7.33 Nitrates!.jpg (3 MB)

Hi Everyone,

I am happy to report that when I read Marc's Nitrate instrumentation this morning - IT WAS AT 7.33!

I do know that there are now other things we have to take into consideration - such as maintaining this! However, I am very encouraged! it!

We have our first of our twice monthly sampling going to our lab tomorrow. I want to see all of our numbers.

Thanks to all of you for your help, assistance and expertise!

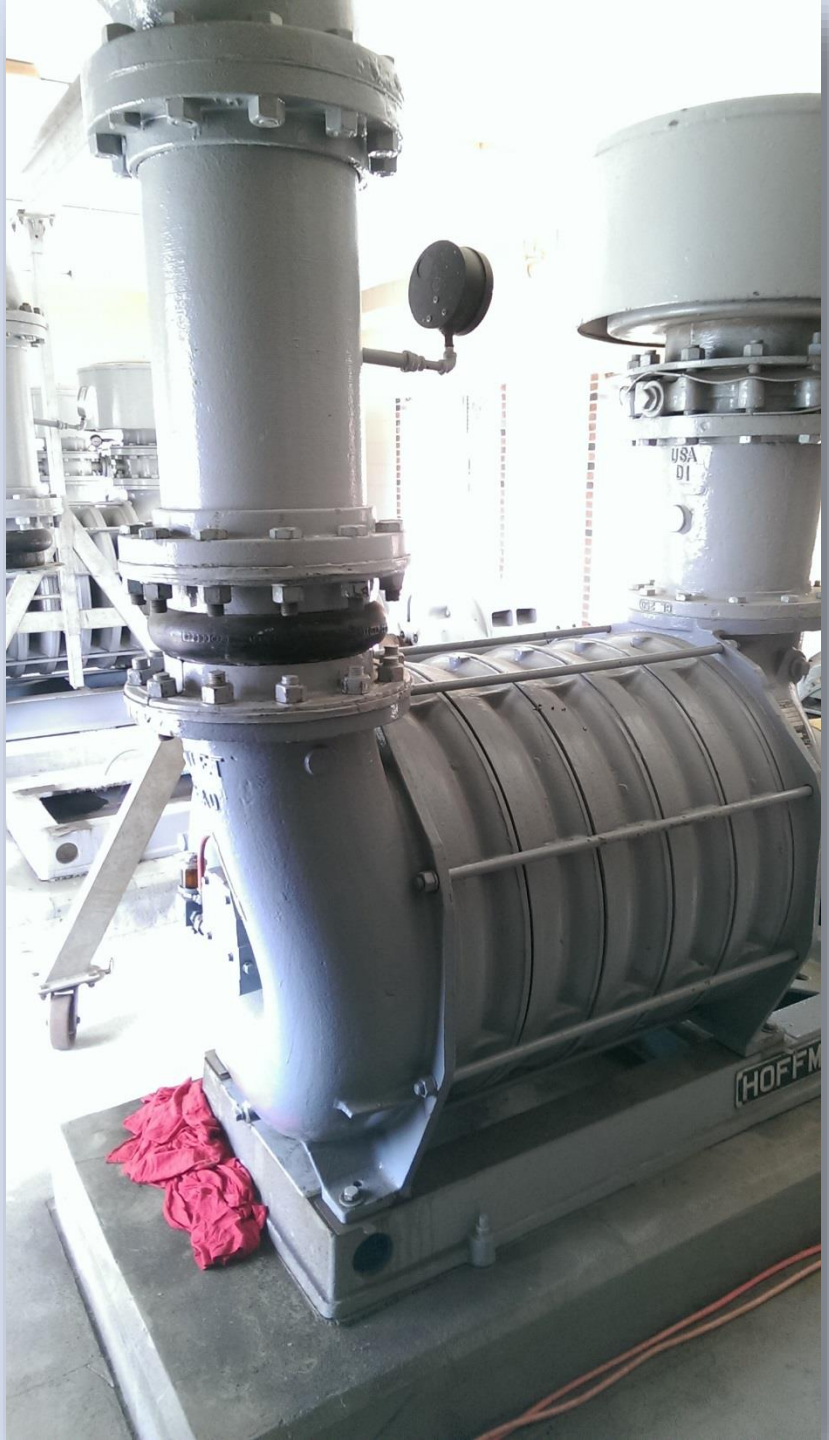
Sincerely,
Reid Heinrichs

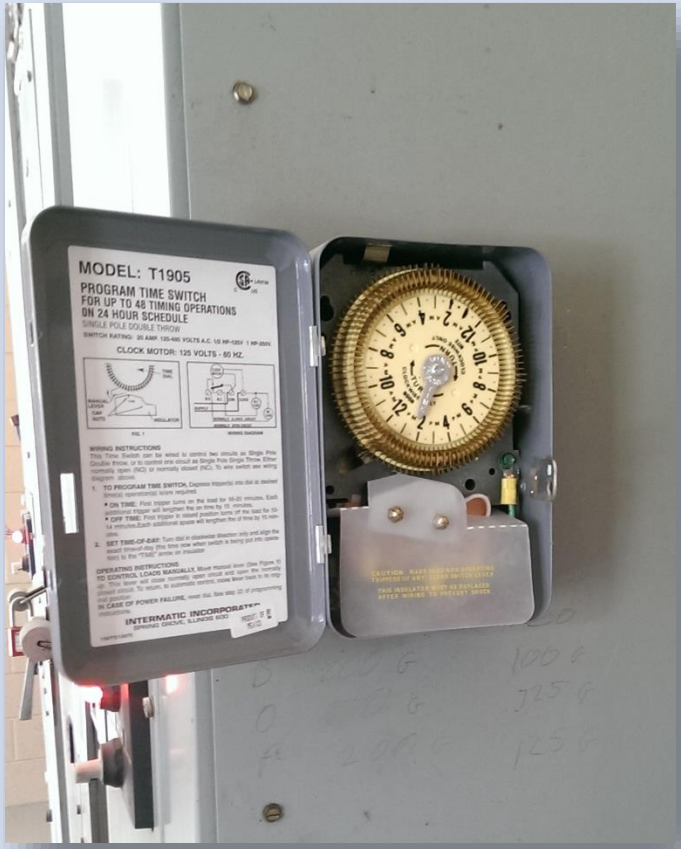
Sewer Operations Manager
Borough of Bryn Athyn
2835 Buck Road
Bryn Athyn, PA 19009
reidh@brynathynboro.org
cell: (267) 358-0970

NO3-N dropped from over 50mg/l to around 5mg/l

Pottstown, PA

- On/Off Aeration
- Establishes an anoxic period
- Total N removal
- Saves energy
- Saves chemicals
- 269,000kWh/yr
- $21,000/yr





Selbyville, DE – Timed Digester Aerators

- Total project cost: $2,000
- Annual energy savings: 480,000 kWh
- $$ savings: $38,000

Effluent Pump Efficiency

Pump #	Date/Time	AC Curr, Amps	Avg Amp	High	Low	runtime (min)	runtime (hr)	kWh/			/mgal	$/mgal	GeoMean	Avg
1	7/2/2015 10:45	53.8186	53.01	53.82	52.72	243	4.05	98			77.27	$ 6.18	$ 9.58	$ 9.85
1	7/3/2015 1:39	101.55	53.24	101.55	52.59	379	6.32	154			27.84	$ 10.23		
1	7/4/2015 15:39	53.8125	52.96	53.81	53.95	355	5.92	144.1	$ 11.5	1.17	123.61	$ 9.89		
1	7/5/2015 10:29	121.593	52.87	121.59	53.05	420	7.00	170.24	$ 13.62	1.05	162.13	$ 12.97		
1	7/6/2015 12:37	89.2866	53.28	89.29	49.56	372	6.20	151.95	$ 12.16	1.22	124.55	$ 9.96		
2	7/8/2015 0:17	52.7108	52.98			243	4.05	98.70	$ 7.90	1.201	82.18	$ 6.57	$ 8.75	$ 8.85
2	7/9/2015 0:00	52.2774	53.11			340	5.67	138.44	$ 11.08	1.149	120.49	$ 9.64		
2	7/10/2015 0:35	49.4636	52.78			338	5.63	136.76	$ 10.94	1.115	122.65	$ 9.81		
2	7/11/2015 0:00	51.9783	52.87			333	5.55	134.97	$ 10.80	1.123	120.19	$ 9.61		
2	7/12/2015 0:34	50.9651	52.34			320	5.33	128.42	$ 10.27	1.195	107.46	$ 8.60		
3	8/5/2015 0:00	57.7768	57.77			357	5.95	158.11	$ 12.65	1.152	137.25	$ 10.98	$ 10.60	$ 10.62
3	8/6/2015 0:00	57.4533	57.64			372	6.20	164.38	$ 13.15	1.217	135.07	$ 10.81		
3	8/7/2015 0:00	58.0545	58.21			378	6.30	168.69	$ 13.50	1.248	135.17	$ 10.81		
3	8/8/2015 0:36	79.3561	58.14			365	6.08	162.70	$ 13.02	1.196	136.04	$ 10.88		
3	8/9/2015 0:21	57.4746	57.70			316	5.27	139.80	$ 11.18	1.014	137.87	$ 11.03		
3	8/10/2015 0:11	58.1064	57.83			304	5.07	134.78	$ 10.78	1.17	115.20	$ 9.22		

Exeter Township WWTP, PA

Total project cost: $227,069
Total incentive: $70,458
Savings: 640,530 kWh/yr
Payback of 3.5 years.

Questions?

Walter Higgins

higgins.walter@epa.gov

215-814-5476