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CASE STUDY
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Anaerobic Digester Optimization with Bio-Organic Catalyst®

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One Year Study November 2007 - November 2008

Municipal Anaerobic Digester Optimization Program Index

- Overview Ridgewood Water Pollution Control Facility (WPCF)
- Description of Operating Baselines:
  - Biogas Production
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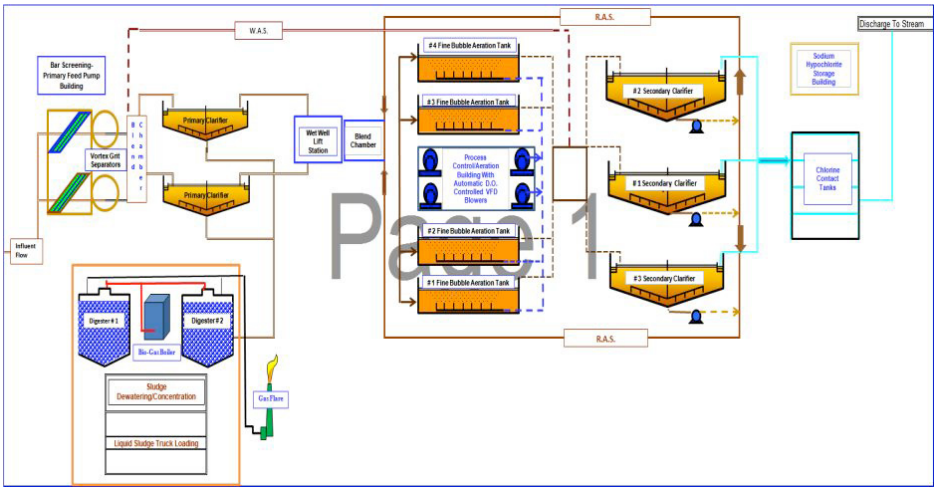
- Summary & Potential Economic Values

Water Pollution Control Facility Ridgewood, N.J.

The Village of Ridgewood located in Bergen County, New Jersey, is the fourth largest community in Bergen County, with a population of 25,500 and land area of 5.79 square miles.

The Department of Public Works - Division of Water Pollution Control, operates the wastewater treatment plant (WPCF) and the sewage collection system. The Ridgewood, NJ WPCF receives an average daily flow of 2.6 - 3.0 MGD. The sewage collection system is 92 miles in length, a combination of gravity and force mains. The lines range from 8 inches to 30 inches in diameter.

There are 6 pumping stations which pump influent flow into the WPCF. The WPCF is operated as an activated sludge plant: with primary clarifiers, secondary aeration, secondary clarifiers, and anaerobic digester. It concentrates digested sludge prior to sending it off-site for incineration.



Ridgewood NJ WPCF Layout and BOC Injection Point

Ridgewood NJ WPCF Anaerobic Digestion (AD) System

- The anaerobic digester functions in the mesophilic temperature range of 38.3o C/101oF.
- The anaerobic digester has a volume of 500,000 gallons/1893 cubic meters.
- The baseline average primary feed sludge loading was 27,500 gallons /104 cubic meters daily.
- The average HRT was 18.3 days.
- Biomethane generated is burned in a boiler to heat incoming primary feed sludge and to maintain the digester temperature. Excess biomethane is flared off.
- The clear liquid "supernatant" is withdrawn from the top of a 500,000 gallons/1893 cubic meter holding tank and recycled to the influent wet well.

Analytical Values of Anaerobic Digestion during BOC Optimization Program

Anaerobic Digestion analytical values:

- Biomethane yields;
  - Per cubic feet (CuFt3)!
  - Per dry lb. of T.S. & T.V.S.
  - Per dry Kilo T.S. & T.V.S.
  - Per gal. of primary feed sludge.
  - Per 100 gals. of influent flow.
- Reduction/replacement in the consumption of natural gas in boiler heating anaerobic digesters (AD).
- Reduction of digester sludge volumes and weight.
- Reduction of aeration energy consumption in secondary aeration channels, i.e. energy used (kWh/Lb of CBOD5).
- Reduction of volatile organics for odor reduction in digester dewatering operation and dewatered sludge.

Operating Baseline Values and BOC Injection Period

Comparison Of Flows & Loading-Baseline Values Vs. BOC Injection Period

Influent Flow & Loading Conditions			Baseline Period Aver. 03/07-7/07	BOC Optimum Injection Period Aver.-3/08-7/08	Notes: Increased or (Decreased)	% Increase (*Decrease*) Over Baseline
Influent Flow & Loading Conditions	Average Daily Influent Flow	MGD	3.45	*2.45*	*Decreased*	*(29 %)*
		100 GPD	34,510	*24,559*	*Decreased*	
		Cu m^3/Day	13,060	*9,274*	*Decreased*	
		Cu m^3/Sec	0.151	*0.107*	*Decreased*	
	TEMPERATURE	TEMP.-^{0}C	19.1	*17.9*	*Decreased*	*(6.5 %)*
	$CBOD_5$	mg/L	194.9	*202.0*	Increased	3.6%
	T.S.S.	mg/L	232.3	*266.3*	Increased	14.6%
	AMMONIA-N	mg/L	10.9	*18.5*	Increased	69.7%
	TOTAL P	mg/L	4.89	*6.3*	Increased	28.8%
	Grit Removal	Cubic Ft/Month	259	367	*Improved*	

Operating Baseline Values and BOC Injection Period

Comparison Of Flows & Loading-Baseline Values Vs. BOC Injection Period

Primary Effluent Conditions			Baseline Period Aver. 03/07-7/07	BOC Optimum Injection Period Aver.- 3/08-7/08	Notes: Increased or (Decreased)	% Increase: (Decrease) Over Baseline
Primary Effluent	Primary Effluent: $CBOD_5$	mg/L	86.3	*79.1*	*(Decreased)*	8.3 %
	Primary Effluent: T.S.S.	mg/L	102	*104.0*	Increased	2 %
	% Removal Of $CBOD_5$ (Infl. vs. Primary Effluent)		56.2%	*59.3 %*	Improved	5.5 %
	% Removal Of T.S.S.- (Infl. vs. Primary Effluent)		56.3 %	*61.0 %*	Improved	8.3 %

Plant Effluent-Comparison Of Baseline Values Vs. BOC Injection Period

Plant Effluent Conditions			Baseline Period Aver. 03/07-7/07	BOC Optimum Injection Period Aver.-3/08-7/08	Notes: Increased or (Decreased)	% Increase *(Decrease)* Over Baseline
Plant Effluent	$CBOD_5$	mg/L	7.1	*6.8*	*(Decreased)*	4.2%
	$CBOD_5$ Removal % (Influent vs. Effluent)		96.3 %	*96.5 %*	Improved	0.2%
	T.S.S.	mg/L	6.4	*6.74*		
	T.S.S.-Removal % (Influent vs. Effluent)		97.3 %	*97.4 %*	Improved	
	D.O.	mg/L	6.71	*6.82*	Improved	
	AMMONIA-N	mg/L	1.25	*.95*	Improved	24.0%
	AMMONIA-N-Removal % (Influent vs. Effluent)		88 %	*94.5 %*	Improved	7.4%
	Total P	mg/L	2.98	*3.46*		
	Total P-Removal % (Influent vs.. Effluent)		40.4 %	*42.6 %*	Improved	5.4%

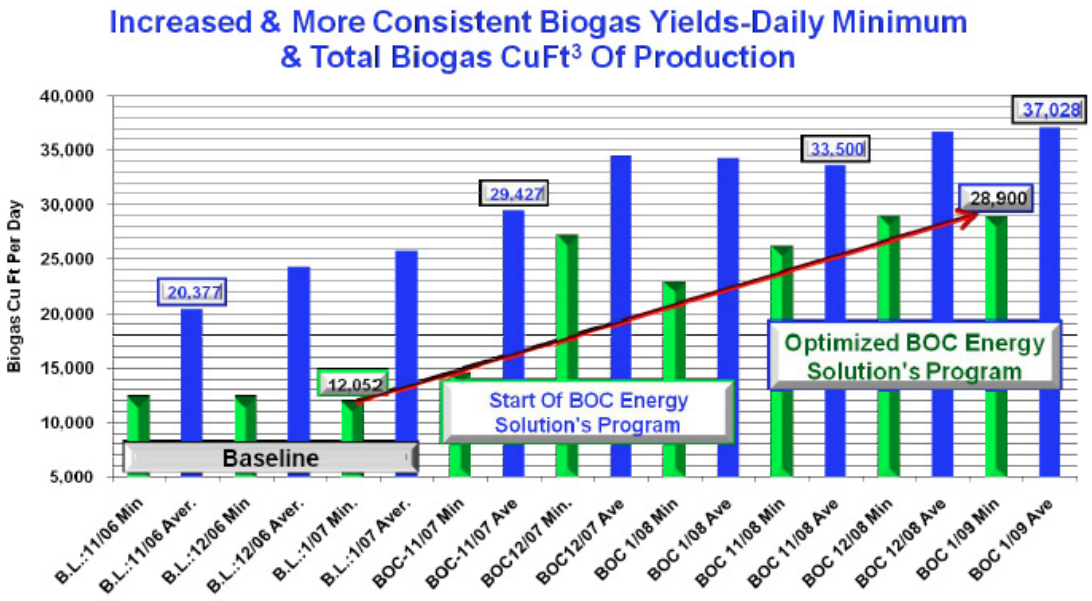
Comparison Of Biomethane Yields (Baseline & BOC Injection Period)

Comparison Of Baseline vs. Optimum BOC Injection Period	Baseline Period Aver. 03/07-7/07	*BOC Optimum Injection Period Aver.-3/08-7/08*	Notes: Increased or (Decreased)	% Increase (Decrease) Over Baseline
Daily Ave Cu m^3 of Bio-Gas Produced	609	*1,031*	Increased	69%
Daily Ave- CuFt^3 Of Biogas Produced	21,518	*36,400*	Increased	69%
HRT-Days	18.4	*15.4*	*(Decreased)*	*(16%)*
Cu m^3 Biogas /Day Of HRT	33.1	*67.3*	Increased	103 %
Cu Ft^3 of Biogas /Day Of HRT	1,167	*2,376*	Increased	103 %
% TS Reduction-(Max)	17.9%	*27.2% (65%)*	Increased	52%
% TVS Reduction with -(Max)	49.6%	*54.0% (75%)*	Increased	8.9%

Comparison Of Biomethane Yields (Baseline & BOC Injection Period)

Comparison Of Baseline vs. Optimum BOC Injection Period	Baseline Period Aver. 03/07-7/07	*BOC Optimum Injection Period Aver.-3/08-7/08*	Notes: Increased or (Decreased)	% Increase (Decrease) Over Baseline
TS Biogas Yield: Cu. ft^3 / Lb (Dry Removed)	8.5	*15.9*	Increased	87.1%
TS Biogas Yield:m^3/Kilo (Dry Removed)	0.530	*0.992*	Increased	87.1%
TVS Biogas Yield: Cu.ft^3 / Lb (Dry Removed)	9.0	*14.3*	Increased	58.9%
TVS Biogas Yield:m^3 /Kilo Dry Removed	0.562	*0.892*	Increased	58.9%
Yield Of Biogas- Cu.ft^3 / 100 Gal Of Influent Flow	.68	*1.44*	Increased	112%

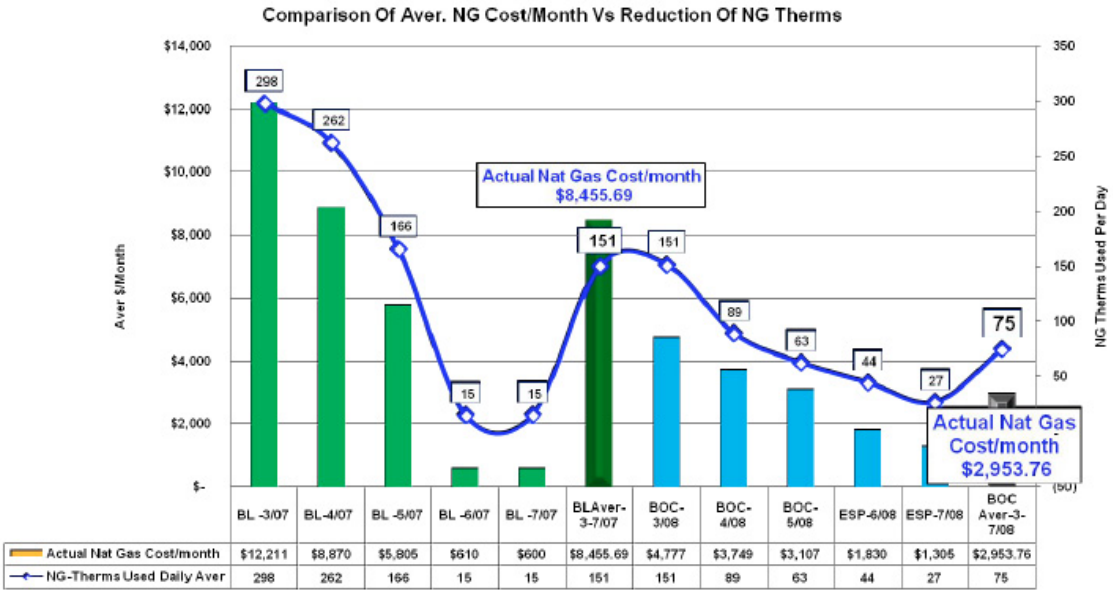
Increased Minimum & Daily Average Biomethane Production (CuFt3)



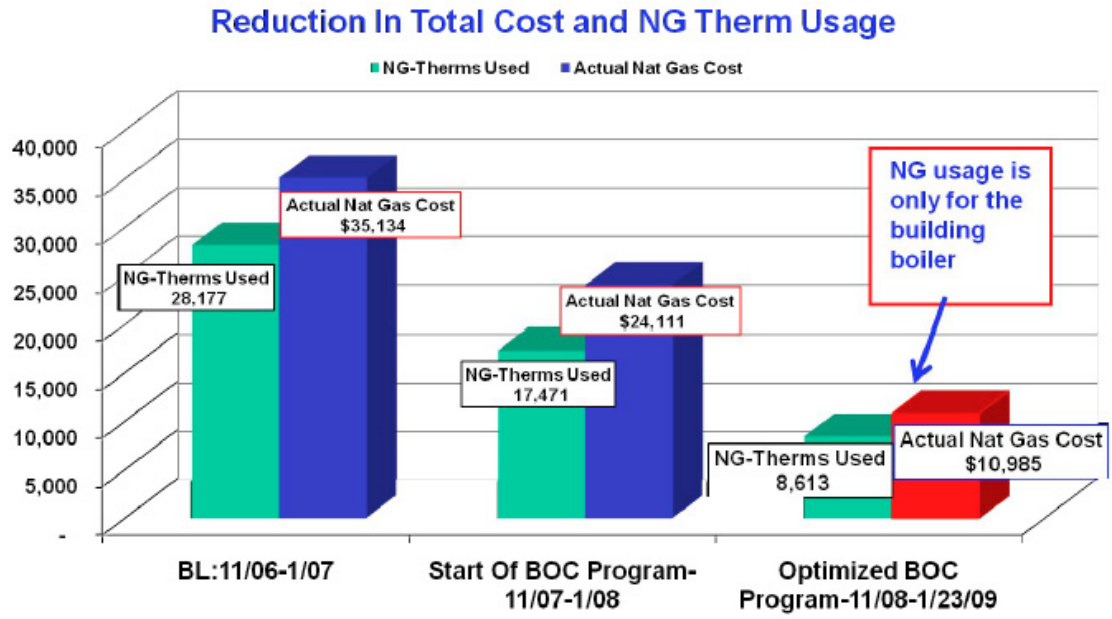
Comparison Of Biomethane Yields (Baseline & BOC Injection Period)

Comparison Of Baseline vs. Optimum BOC Injection Period	Baseline Period Aver. 03/07-7/07	*BOC Optimum Injection Period Aver.-3/08-7/08*	Notes: Increased or (Decreased)	% Increase (Decrease) Over Baseline
Gallons of primary sludge to AD-daily average	27,172	*32,433*	Increased	19%
Daily average-cu ft³ of biogas produced	21,518	*36,400*	Increased	69%
Daily Ave m³ of Bio-Gas produced	609	*1,031*	Increased	69%
Cu Ft³ Of bio-gas required heat primary feed sludge to aver. AD Temp. @ 600 BTU's / Cu Ft³(*1)	16,200	*15,676*	*Decreased*	*3%*
Daily Ave-BTU's Of Biogas Produced	12,910,800	*21,840,000*	Increased	95%
Daily BTU's required heat primary feed sludge to aver. AD temp.	8,100,070	*9,405,563*	Increased	16%
Excess daily biogas BTU's produced	2,659,168	*12,434,437*	Increased	335%
Excess daily cu ft of biogas produced to heat primary feed sludge to aver. AD temp	5,318	*20,724*	Increased	263%

Reduction Of NG Cost/ Month & Therm Usage with BOC Optimization



Reduction In Total Cost and NG Therm Usage



Comparison of Baseline Values & Lower NG Usage and Cost

Comparison Of Baseline vs. Optimum BOC Injection Period	Baseline Period Aver. 03/07-7/07	*BOC Optimum Injection Period Aver.-3/08-7/08*	Notes: Increased or (Decreased)	% Increase (Decrease) Over Baseline
Daily BTU's required to heat primary feed sludge to aver. AD temp.	8,100,070	*9,405,563*	Increased	16%
Excess daily cu ft of biogas produced to heat primary feed sludge To aver. AD temp	5,318	*20,724*	Increased	263%
NG-Therms used daily aver	151	*75*	*(Decreased)*	*(101%)*
NG-Therms/ M gallons of primary feed sludge	5.42	*2.34*	*(Decreased)*	(132%)
Aver.-Nat Gas Cost/month	$8,455.69	*$ 2,953.76*	*(Decreased)*	(186%)
Excess daily biogas BTU's produced	2,659,168	*12,434,437*	Increased	335%

Reduction Of Sludge Volumes

Comparison of Sludge Baseline Values & BOC Injection Period

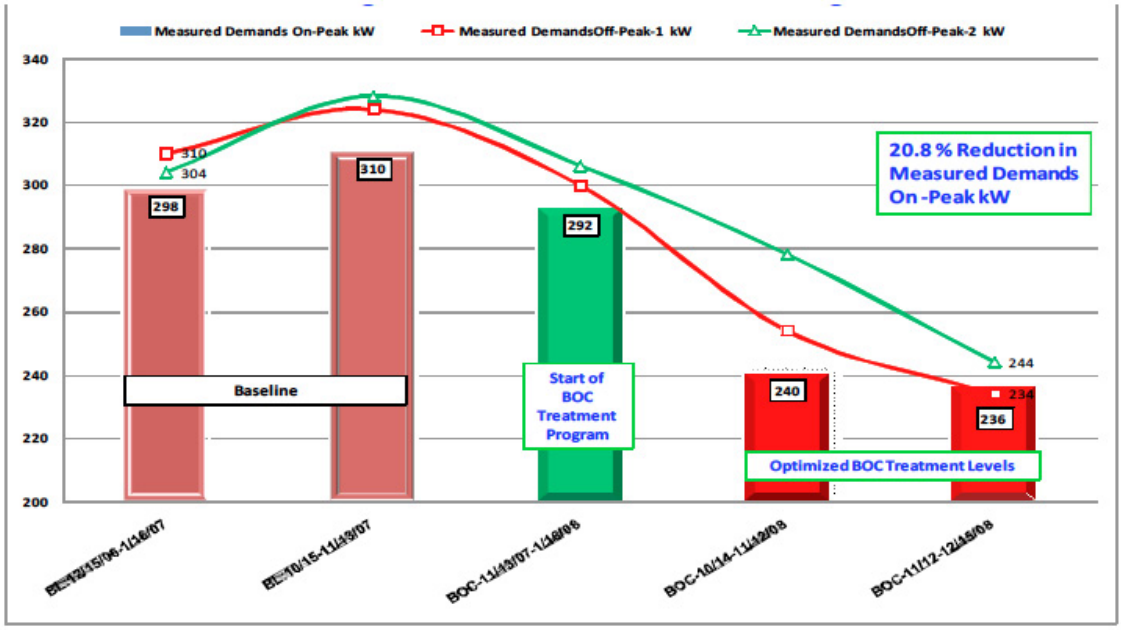
Comparison Of Baseline vs..... Optimum BOC Injection Period	Baseline Period Aver. 03/07-7/07	BOC Optimum Injection Period Aver.-3/08-7/08	Notes: Increased or (Decreased)	% Increase (Decrease) Over Baseline
Influent Flow-MGD	3.45	*2.45*	*(28.9%)*	*Decreased*
Primary feed gallons per gallon of influent flow	0.0085	*0.0128*	33.4%	Increased
% Waste Haulage Gallons Vs Primary Feed Gallons	12.2%	9.1%	*(25.2%)*	*Decreased*
Primary Feed Sludge (GPD)	27,426	*32,216*	15%	Increased
Primary Feed Sludge % T.S.	1.88%	*1.81%*	*(3.8%)*	*Decreased*
Primary Feed Sludge % T.V.S.	85.65%	*85.21%*	*(.5 %)*	*Decreased*
Sludge haulage daily gallon aver	3,166	*2,713*	*(14.3%)*	*Decreased*
Actual Sludge Haulage Volume reduction (Corrected for increased AD loading)			*29.3%*	*Decreased*

Reduction Of Secondary Aeration Energy

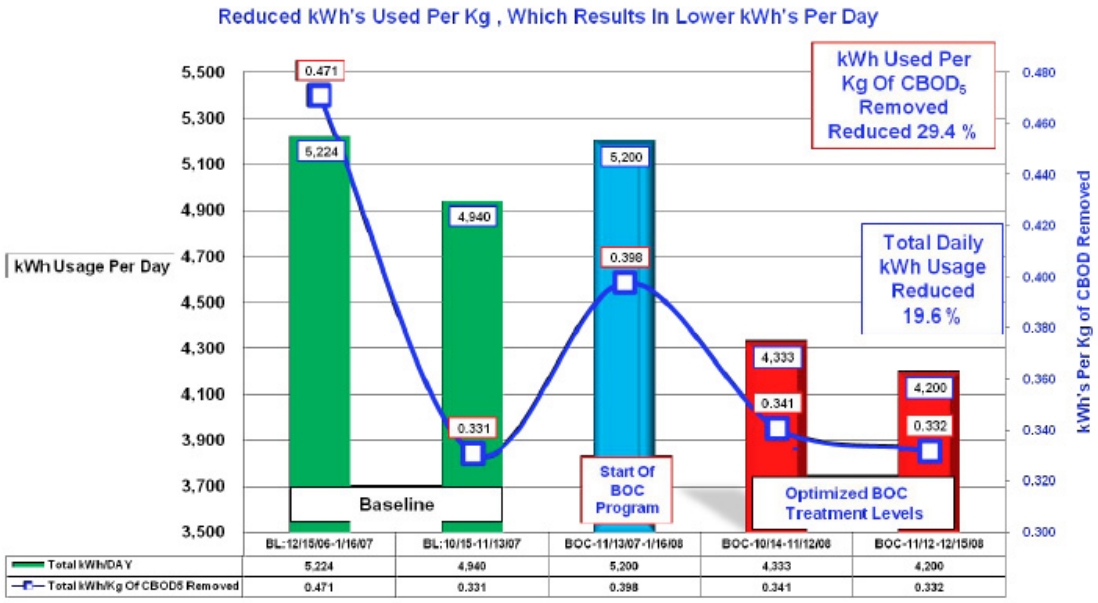
There is a reduction of energy consumption within the facility's aeration channels from the "carry-over-effect" of the BOC injection into the anaerobic digester (AD) as the sludge thickening supernatant is returned to the front end influent wastewater, thereby enhancing the transfer of dissolved oxygen in secondary aeration channels.

- This aeration energy savings provides an important secondary economic value to the BOC process optimization of the anaerobic digester (AD) application.
- The aeration energy savings offers the wastewater operator an additional energy conservation strategy within a volatile energy marketplace.
- Overall aerobic processes and BNR exhibit positive performance characteristics due to improvement of transfer of dissolved oxygen and management of optimum dissolved oxygen levels.
- 20.8% reduction in Measured Demand On-Peak 1 kW.
- 24.5 % reduction in Measured Demand Off-Peak 1 kW.
- 19.7% reduction in Measured Demand Off-Peak 2 kW.
- 29.4% reduction in total kWh's per Kg of $CBOD_5$ removed.
- 20% reduction in kWh's used per day.

Reducing Measured Peak and Off Peak kWh Usage



Reduced kWh's Usage Per Day, per Kg

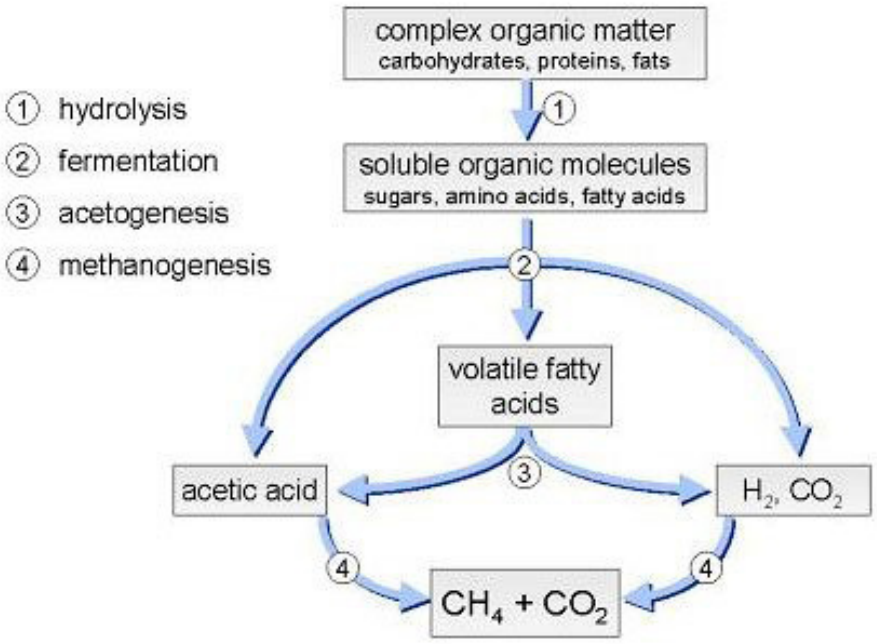


Secondary Aeration Energy Savings Per Day & Annually

- Based on the average prior baseline kWh usage of 5,224/day and the reduction of 1,000 kWh per day, daily and annual electrical savings are calculated as follows:
- The average daily energy cost (kWh) during the early baseline period (12/15/06-1/16/07) was $.099/kWh, during which 5,224 kWh's were used. The prior average daily energy cost per day was $519.64.
- During the BOC Optimization period the average daily energy cost rose to $.1327/kWh, or the equivalent of $693.22 per day
- At a savings of 1,000 kWh daily, this translates to a savings of $132.67 per day, and a savings of $48,424.55 per year.

Anaerobic Digestion Optimization With BOC

The Anaerobic Digestion Sequence



Anaerobic Digestion Optimization with BOC

- The bio-catalytic action of BOC on the various organic components of a sludge waste stream, including the lipids, indicates that there is an accelerated release of high nutrient values to indigenous microbiological populations within the bio-digester system.
- This leads to a faster transition to the Methanogenesis phase, along with higher microbiological vigor, producing a more complete biological consumption of TS & TVS.
- This study showed a correlation to biomethane yield improvements and TS & TVS consumption rates. This 1 year study demonstrates these trend lines as optimization is reached.
- Distinct qualitative characteristics of sludge discharged from AD exhibited substantial odor reductions, which follows from a more complete consumption of TVS components.

Summary Of BOC Anaerobic Digestion Optimization

- 69% increased biogas production produced an annual savings of $38,500 in NG purchases against the baseline period.
- Increased biomethane yields offer potential further annual NG savings of $24,500 - $31,000 through a reduction, or elimination, of NG usage in Building Boiler.
- 29.3% reduction of sludge volumes offers projected savings annually of $18,945.38.
- Reduction of secondary aeration energy usage on total kWh's used per Kg of CBOD5 has been reduced by 29.4%, for a savings of $132.67 per day, or a savings of $48,424.55 per year.

The study participants and authors would like to thank the New York Water Environment Association for the opportunity to present this study on Anaerobic Digestion Optimization at their 2009 Annual Meeting - February 3, 2009.

Mr. Chris Rutishauser, P.E., CPWM, Village of Ridgewood
Mr. Bob Gillow, Superintendent, Village Of Ridgewood ,Water Pollution Control Facility
Mr. Greg Burde, Senior Sales Executive, Hydra-Numatic Sales Co.
Mr. Jay Johnston, Executive Vice President, Bio-Organic Catalyst, Inc.
Mr. Parker D. Dale, President, Bio-Organic Catalyst, Inc.