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CASE STUDY
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Optimization of Anaerobic Digestion with Bio-Organic Catalyst Compositions (BOCs)

14th Annual European Biosolids and Organic Resources Conference and Exhibition - November 2009

The Royal Armouries, Leeds, UK

Anaerobic Digestion (AD) offers excellent opportunities to convert organic waste streams into environmentally safe bio-solid while generating renewable energy through the bio-methane produced by the microbiological populations processing the wastes.

- Anaerobic digestion offers an effective organic waste stream treatment solution that reduces pollution loadings to environmentally safe discharges.
- The bio-gases produced within the microbial populations of the AD systems contain renewable energy potential from the percentage of bio-methane in the bio-gases that are generated through the biological reactions.

These two characteristics comprise the twin pillars of the economic value proposition to the AD system operator/owner. Extensive work in both municipal and food processing anaerobic digesters has shown that BOC's offer great potential in optimizing anaerobic digestion conversion rates, while addressing and improving chronic operational challenges of operators in obtaining optimal renewable energy production and high quality bio-solids.

Challenges Of Anaerobic Digestion

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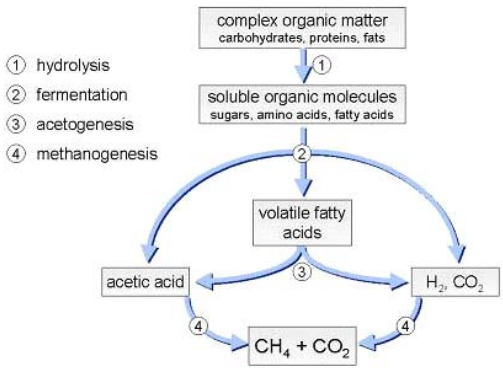
The mechanism of bio-catalysis of BOCs on the waste stream components sets into motion an accelerated molecular breakdown of the biomass enabling a corresponding acceleration of the anaerobic digestion processes within the AD system. There are numerous aspects that will impact the complete biological conversion of the total organic solids (TS), and most importantly the total volatile solids (TVS).

The operation of (AD) system is dependent upon feeding the four (4) phase anaerobic digestion process.



Economics of Anaerobic Digestion

The economics of anaerobic digestion are closely led to obtaining optimal renewable energy bio-methane yields, which offsets fossil fuel energy purchases, which are used to heat and maintain AD temperatures.

- The ability of increasing bio-methane yields directly reduces natural gas or fuel oil purchases and, increasingly, carries values in generating renewable energy or carbon reduction credits.
- Accelerating and optimizing the anaerobic digestion rates expands the capacity of anaerobic digester systems through enhanced biological vitality, and also impinges directly on the capital equipment investment (CAPEX) of combined heat and power (CHP) required to utilize bio-methane production.

Problems encountered in anaerobic digesters generally are led to the difficulties of converting various components of the waste stream during anaerobic digestion, leading often to a decrease in bio-methane yields over time, and a reduction of usable renewable energy cash flows.

Most anaerobic digesters are often challenged by biomass loadings that can result in reduced bio-methane yields and require expensive maintenance cleaning, in addition to decreasing renewable energy production. The organic materials that represent the highest bio-methane values are also the organic components that cause these problems: *The volatile organic solids*.

BOCs directly act on these high value components of wastes, accelerating the anaerobic digestion processes into more optimized conversion efficiency. Case studies show a much higher yield per pound, or kilo, of organic waste biogas, while clearing the internal accumulations that build up over time.

BOCs require little capital equipment expenditure, as installations involve simple injection pumps, along with a reservoir of BOCs.

- Results become evident relatively quickly, as a faster release of high bio-methane value components of the waste material shifts the internal biomass within the anaerobic digester into the Methanogenesis phase, increasing the bio-methane yields and total consumption of volatile fatty acids.

Use of Bio-Organic Catalyst Compositions

Food Processing AD Systems: The use of BOCs evolved out of their use within the aeration channels of a large, professionally managed international food manufacture wastewater treatment facility. These aeration channels were not able to meet desired dissolved oxygen levels in spite of having both surface aerators and fine bubble diffusers working at maximum capacity. Additionally, heavy lipid (FOG) accumulation had covered the aeration channels. There were odor and bio-solids' management issues as well.

- The use of the BOCs immediately results in raising dissolved oxygen levels and very quickly solubilizing the accumulated FOGs that had covered the entire aeration channels.
- This allowed the client to meet much higher loadings than their facility was designed for and engendered confidence in the BOC ability to rapidly solubilize lipid molecular wastewater components.
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Use of BOCs (Food Processor)

Due to the wastewater loadings having higher actual organic loadings exceeding their design capacity, along with high concentrations of FOG, the advanced AD system required a flow equalization tank and other load balancing procedures to manage the influent loads. They were being challenged during production cycles that exceeded their AD system design parameters. It resulted in:

- Over time, the surface media within their AD system accumulated FOG components that reduced the efficiency of the internal microbiological populations to perform optimum biological conversion of the influent biomass loadings.

In starting up the introduction of BOCs into the AD system, a reduced dosage level, compared to established aeration channel loadings and dosage levels, was initiated at the beginning of the trial program. In order to provide adequate solubilization of the complete wastewater components, especially the FOG elements, BOCs were injected into a collection well, prior to the flow equalization tanks. This allowed a threshold--adjusted solubilization of accumulated FOG elements as the BOCs were injected into the wastewater influent that was entering their AD system.

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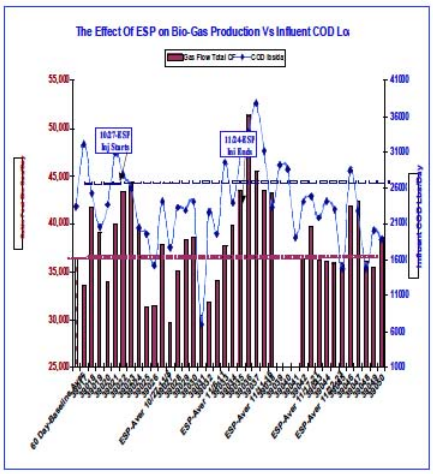
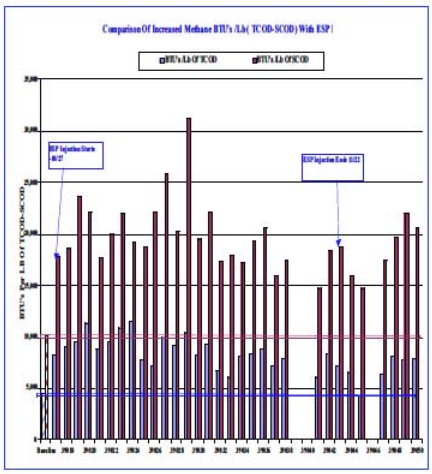
Initially, there was a release of concentrated FOG deposits within their AD system that could be observed in their secondary aeration basins that received the discharges from the AD system. Over a few days, the FOG deposits were cleared out of the AD system and the bio--methane production curves began to show improvements.

Since their AD system is highly automated for optimized biological conversion efficiencies, acid/alkalinity ratios and pH adjustments were possible on a real time basis. As they are required to manage high FOG loadings in their industry sector facilities, they were very focused on the challenges of obtaining good biological conversions of volatile fatty acids. As the acclimation of the internal microbiological populations adjusted to the solubilization of FOGs, and the vitality of their reproduction and biological conversion efficiencies reached a higher zone of Methanogenesis, bio-methane yields began to rise over baseline production values. An optimum dosage of BOC began to evolve to the wastewater loadings and reveled an optimization improvement potential that averaged an improvement range up to 30% over baseline values.

Higher Yields Of Biomethane In A Food Processing Wastewater AD System.





Additional BOC installations (Food Processors)

This success led to additional food processing facilities managed by the wastewater operator that were experiencing difficulties of adequate performance within differently designed wastewater treatment systems designs, in which the AD systems had experienced nearly complete shutdowns of the AD system due to toxic chemical discharges into their wastewater that essentially crashed the anaerobic biological performance of their AD system.

BOCs in Municipal AD System

The experiences with various food processing operations and their ad system, led to the decision to explore the potential to treat municipal ad systems. The use of ad systems within municipal wastewater treatment facilities represents a significant installed base throughout the world and, with the recent new emphasis on cost containment and renewable initiatives by governmental bodies, there is a strong incentive to generate maximum yields from bio-methane potential within the existing installed base of ad systems in order to more fully utilize the availability of co-generation packages.

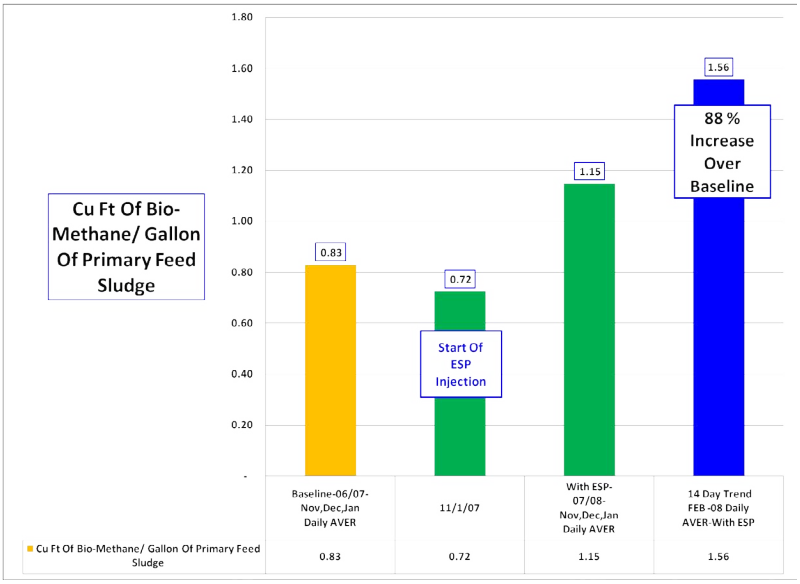
- Extending the applications scope of using bocs in optimizing ad systems, a 3 MGD municipal WWTF was approached to serve as a site for a one-year evaluation study that would look at the complete mass balance analysis of both ad system optimization, as well as the corresponding impact on aeration energy usage and total water quality of their discharges. This one--year study allowed an evaluation of a four season cycle, with cold northeastern us winter temperatures, variable spring and fall temperature ranges, and warmer summer temperatures.

(Ref: 2009 NYWEA 81st Annual Meeting presentation by Bio-Organic Catalyst, Inc.)

Bio-methane generated in the AD system provided heating for the AD system in the boilers, which was supplemented by outside purchases of natural gas to maintain adequate AD temperature for the anaerobic digestion processes. Excess bio-methane gas generation was not utilized, but flared, so that with nearly 70 -90% greater bio-methane generation after reaching optimal bio-methane yields per dry weight bio-solids, resulted in planning for acquisition options of a co-generation equipment package to more fully utilize the additional excess bio-methane and renewable energy potential they now have available. Beginning in November 2008, injection of BOCs was initiated into the sludge feed line at various dosage levels, prior to the AD system.

- Average daily volume ran between 25, 000 to 30,000 gallons daily, with a sludge feed of 2.5% solids.
- HRT averages 20 days.

The following chart shows the rise of bio-methane yields as the dosage rate rose until a clear zone evolved of optimal bio-methane yield per gallon of sludge, and a maximum yield per dry lb. of TVS.



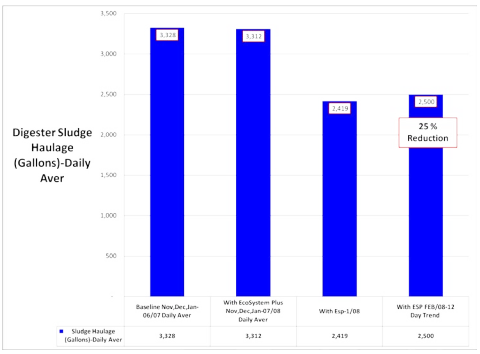
Increased Biogas Production-Municipal Ad Systems

Biomethane Production Increased 88% Per Gallon Of Primary Feed Sludge

BOC Usage in Municipal AD Systems

- Aeration energy reductions, due to the recirculation of BOC in the supernatant returning back to the influent wastewater and positively impacting aeration energy usage within the secondary aeration channels, showed approximately 30% savings.
- Furthermore, an analysis was conducted to evaluate the total effluent discharge levels correspondence to prior baseline values. Final biosolids quality and hauling reductions were correlated against baseline operating cost centers.

Digester Sludge Hauling Volume Reduced 25%

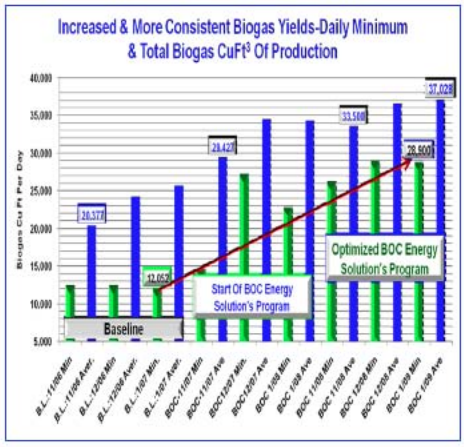


BOC Usage in Municipal AD Systems

Increased Biogas Yields:

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. ft³ / Lb (Dry Removed)	8.5	15.9	Increased	87.1%
TS Biogas Yield:m³/Kilo (Dry Removed)	0.530	0.992	Increased	87.1%
TVS Biogas Yield: Cu.ft³ / Lb (Dry Removed)	9.0	14.3	Increased	58.9%
TVS Biogas Yield:m³ /Kilo Dry Removed	0.562	0.892	Increased	58.9%
Yield Of Biogas-Cu.ft³ / 100 Gal Of Influent Flow	.68	1.44	Increased	112%

Increased & More Consistent Biogas Production



Optimization of Anaerobic Digestion with BOCs

A complete mass balance analysis of using BOCs shows benefits over a number of critical costs of operations, including:

1) Higher bio-methane yields.
2) Lower bio-solids hauling weight and volumes,
3) Substantial reduction of bio-olids odors.
4) Reduction in aeration energy requirements through recirculation of dewatered liquids
5) Total nitrogen reductions and Improvements in all discharge values of a facility, including BNR discharges.

Conclusion

The bio-atalytic actions of BOCs upon the AD system influent biomass, prior to their inflow into various AD systems, produces very useful and notable improvements to critical parameters to the operations of an AD system.

- Applications in municipal and food processing AD systems showed close correlations between higher TS and TVS conversion rates and higher bio-methane yields on a dry weight comparison, pointing towards an acceleration of the phased Methanogenesis cycle. This results in total overall enhancement of complete biomass vitality and microbiological population densities involved in the anaerobic processes required for optimal bio-methane yields and BTU values. The combined total mass balance analysis shows improvements in obtaining optimal bio-methane yields,
- On a dry weight TVS basis, can run from 25% – 100% over comparable baselines. Additionally, the final biosolids quality and weight reductions (up to 25%), including substantial elimination of noxious biosolids odors, all indicate a more complete biological conversion of nutrient values.