November 2017

The Wastewater Insight

Environmental Leverage INC.

Turning Liabilities into Leverage

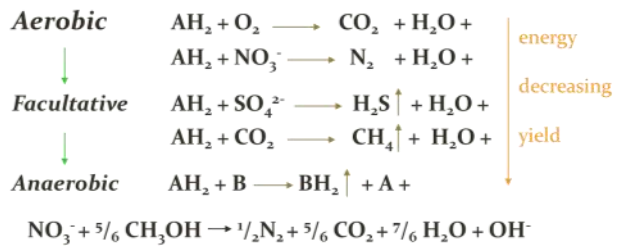
Denitrification

As more and more plants are being forced to achieve total N removal (this included ammonia, organic nitrogen, nitrates and nitrites), process changes are being forced.

Industrial facilities such as chemical, mining or refining usually have high levels of nitrogen and are used to achieving high levels of nitrogen removal.

Municipalities in the past were just used to having to remove ammonia. Food plants such as wineries may have high nitrates. Meat plants easily have high nitrogen, both organic and ammonia. Animal feed lots have high levels of both N and P. Newer stricter permits are forcing many of these facilities to rethink how they achieve nutrient removal.

- **Facultative respiration uses chemically bound oxygen when dissolved (free) O_2 is not available:**
  - **Metabolism using chemically bound O_2 yields less energy than aerobic (free O_2) metabolism, in sequence of energy yield potential**



For some plants, it becomes a math balance of how much BOD do you have that will take up the nutrients as a nutrient source. For every 100 parts of carbon, 5 parts of ammonia and 1 part of ortho-phosphate should be used up in a normal aerobic process. What is left over must have nitrification and possibly Denitrification in order to completely remove the N from the system.

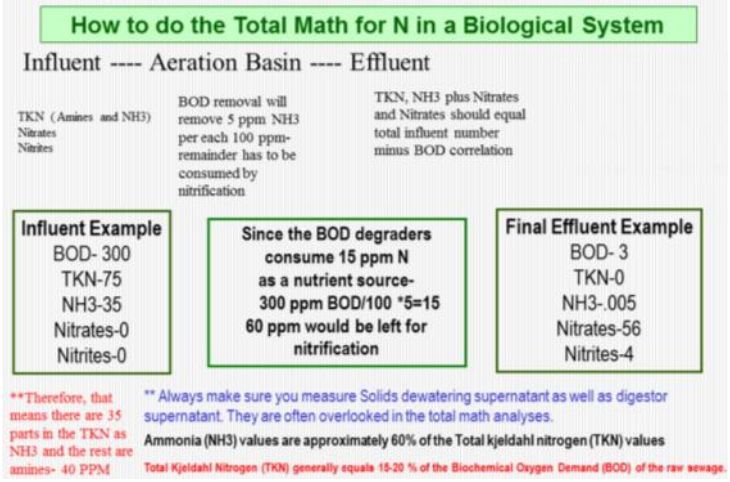
Some things to consider:

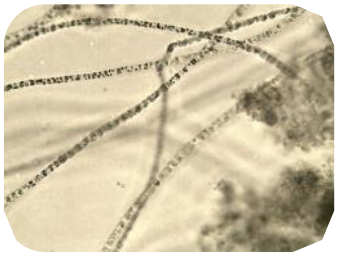
BOD to N and P ratio Math balance	Holding solids too long in a digester and benthal feedback of nutrients
No oxygen during Denitrification	Overload of chemicals such as polymers with excess N
Sufficient alkalinity during nitrification	Sufficient amine breakdown

Math Balance: When trying to calculate nutrient removal it is always best to start with a math balance across your system. Don't forget to not only measure influent nitrogen along with BOD/TOC but also what is coming off your dewatering or digester decant as well.

Denitrification (gasification) is the reduction of a nitrate (NO3-) by heterotrophic (carbon degrading) bacteria which use the molecule as a chemical oxygen source to support their respiration requirements in the absence of sufficient dissolved oxygen availability. The by-product is N2 gas, so the nitrogen is removed from the final effluent. Facultative respiration uses chemically bound oxygen when dissolved (free) O2 is not available,

The less free oxygen, the slower the reaction time. Basically





We started this month out with a new **Mystery Bug of the month!**

Check out our website for more photos of our new mystery bug!!!!

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the only thing different during denitrification is that you are turning off the air and forcing your carbon bacteria to choose a harder, slower process by using nitrates as an alternate oxygen source. The other Critical 5 are still relative to the process.

Many municipalities are high in nutrients but low in BOD. Some plants purposely have to denitrify since they have total nitrogen limits in their final effluent permit. Many municipalities have issues with achieving sufficient total nutrient removal. They barely have enough BOD to perform normal ammonia removal. Then a secondary process required BOD to denitrify so they have to add some sort of carbon source, such as methanol or glycerol to add supplemental carbon to denitrify. Do not add dog food or rabbit food, they are very high in BOD and FOG and can cause other issues. Look instead to see if you have a local food plant. Many times they have bad batches of product, or highly concentrated syrups. We have worked with many food and beverage facilities that pay to haul off their extremely concentrated waste. Maybe for a small exchange both facilities would save money.

Additional Carbon Sources:

Methanol in the past was a carbon source used quite often. Methanol has high costs -$0.70 to $3.00 per gallon, additional storage requirements along with safety issues and increased sludge generation are all things to think about when choosing an extra carbon source.

Product quality control as well as costs are definitely considerations. Many plants are now switching to waste biodiesel glycerol as a carbon source.

**General rule of thumb 2 parts of nitrate per part of carbon

Typical Sources of Carbon

Methanol

Ethanol

Acetic Acid

Spent sugar from food and beverage

Glycerol from bio-diesel production

	Methanol	Ethanol	MicroCg™	MicroCglycerin™	56% Acetic Acid	30% Sodium Acetate
COD mg/L	1,200,000	1,650,000	670,000	1,016,000	577,000	222,480
Bulk Density lbs/gal.	6.6	6.6	10.2	9.92	9.09	9.8
Yield g COD/g COD	0.41	0.55	0.6	0.55	0.53	0.53
Total COD/N	4.82	6.36	6.45	6.36	6.09	6.09
Total dose gal substrate/ lb NO3N	0.48	0.46	1.15	0.77	1.19	3.09

Table 1: Product Characterization for Some External Carbon Sources

Glycerol is added as a carbon source for denitrification at this plant. Total carbon to nitrogen to ortho phosphate analyses should be correlated regardless of carbon source. Total carbons present in the influent from the plant as well as from polymer used, or biodiesel used should be calculated and used in a math balance to correctly add the proper chemicals, yet optimize the system for complete nutrient removal at any plant.

	Alcohols		Acetate		Carbohydrates			Co-products	EOSi Products	
Product Attribute	Methanol	Ethanol	Acetic Acid*	Sodium Acetate**	Corn Syrup	Molasses	Sucrose Solution	Crude Glycerin	MicroCg	MicroCglycerin
Safety / Flammability	1	1	2	4	4	4	4	4	4	4
Price Volatility	2	2	2	2	3	3	3	2	3	3
Rate of Denitrification	2	4	4	4	3	3	3	3	3	4
Viscosity / Handling	4	4	4	3	1	1	1	2	4	4
Freezing Point	4	4	4	1	2	2	2	3	3	4
Product Stability	4	4	4	4	2	2	1	3	4	4
Supply Availability	4	4	4	4	4	4	4	2	4	3
Quality Control	4	4	4	4	4	3	3	1	4	4
Cost	4	3	1	1	1	2	2	3	2	3
Large body of technical literature	4	4	4	4	2	2	2	2	3	3

4 Very Good
3 Good
2 Fair
1 Poor

*56% solution **30% solution. Requires mixing

Table 2: External Carbon Sources and Evaluation of Some Common Attributes

Pure glycerin has a Biochemical Oxygen Demand (BOD) of nearly 1,000,000 mg/l.

Make sure to test each batch of the glycerol each time a new delivery occurs, as it is very easy for the quality to change since this really is a "byproduct" from a production run for biodiesel.

Glycerol from Biodiesel:

There are numerous sources of glycerol as well as different production processes.

Depending upon the source the biodiesel company uses for productions as well as they type of biodiesel process, variations in the byproduct glycerol can easily change the composition of the glycerol that is used for the denitrification plant.

Chemical compositions of crude glycerol: The chemical composition of crude glycerol mainly varies with the type of catalyst used to produce biodiesel, the transesterification efficiency, and recovery efficiency of the biodiesel, other impurities in the feedstock, and whether the methanol and catalysts were recovered. All of these considerations contribute to the composition of the crude glycerol fraction. For instance, Hansen *et al*. [4] studied the chemical

compositions of 11 crude glycerol collected from 7 Australian biodiesel producers and indicated that the glycerol content ranged between 38% and 96%, with some samples including more than 14% methanol and 29% ash.

Some processes use **red mud** as a catalyst. Utilization of red mud as a catalyst for biodiesel production not only provides a cost-effective and environmentally friendly way of recycling this solid red mud waste, significantly reducing its environmental effects, but also reduces the price of biodiesel to make biodiesel competitive with petroleum diesel. The problem with this is the impurities or toxicity this may have to a wastewater treatment plant

MATERIAL SAFETY DATA SHEET

SECTION 1 - IDENTIFICATION DATA

EMERGENCY TELEPHONE NUMBER:
Beaver Biodiesel LLC
650 NW Harrison Blvd, Corvallis, OR 97330
(503) 880-2060
EFFECTIVE DATE: 2/15/2010
Common Name: Crude Glycerin
Chemical Name: Propantriol, 1,2,3-Propantriol
Formula: HO-CH2-CH(OH)-CH2-OH
Molecular Weight: 92.09 g/Mol
Chemical Family: CAS No: 56-81-5

SECTION 2 – INGREDIENTS AND HAZARDOUS CLASSIFICATION

Hazardous Components	Percent	CAS No.	OSHA PEL	ACGIH PEL
Glycerin	65-85%	56-81-5	15 mg/m3 (mist)	10 mg/m3 (mist)
Methanol	12-31%	67-56-1	TWA 200ppm	TWA 200ppm
Sodium Methylate	4 – 8%	124-1-4	Not Established	Not Established

Red mud is a toxic byproduct of the industrial process that refines bauxite, raw aluminum ore, into aluminum oxide, or alumina. (Alumina is put through a separate process, electrolysis, to make aluminum metal.) In addition to iron, the other dominant components include silica, residual alumina, and titanium oxide.

If your plant that you purchase your biodiesel uses red mud or any other iron upstream, keep in mind that iron, alum or lime all can bind phosphorus. This will offset your addition of phosphorus to the plant as a nutrient source. This will also slow down the denitrification process, increase filaments or even Zooglea as well. Make sure to ask exactly how they make their biodiesel or put all information on the SDS sheet. Just keep in mind with denitrification, you cannot have high levels of DO present or no denitrification will occur. If you run out of nitrates, then it just turns septic. Don't hold your digester solids too long, or all the N and P that you took out normally will just be re-released back into your system. Test the decant of your digester or dewatering backwash for N and P. Lower your time in the digester and change polymers or make sure not to overdose.

ANOXIC -Absence of molecular oxygen (i.e.; bacteria must depend upon facultative respiration, using oxygen bound in nitrates and sulfates, yielding less energy than aerobic metabolism - but, more energy than anaerobic metabolism)

$AH_2 + NO_3^-$ ----Ø $N_2 + H_2O$ + energy

$AH_2 + SO_4^{2-}$ ---Ø $H_2S + H_2O$ + energy

$AH_2 + CO_2$ ----Ø $CH_4 + H_2O$ + energy

Also make sure to breakdown amines. Use bioaugmentation upstream in the lift stations if necessary to give you more time and utilize the collection system to help. Some plants also may decide to use the grease that they took out of the primary to help add extra carbon. Bioaugmentation can also help with breakdown of the grease, increased uptake of the N and P, yet help outcompete some of the filaments that do not take up as much N and P. Floc formers also take up less space, reduce solids handling costs by 40-60% so make sure you are trying to achieve BOD, TSS and nutrient removal with floc vs. filaments to save costs at your facility, yet achieve the best results.

Product Corner

FOG (fats, oils & grease) can build up in pipes, lift stations, grease traps & wetwells. When FOG cools to ambient temperature it can cause float problems, grease ledge or create large chucks which cause flow blockage problems as well.

FOG is a carbon with very high BOD and the bacteria will consume it. As long as there is food present for the bacteria to grow, they will grow in the collection systems. Without proper mixing or aeration odors can occur. Odor becomes a big issue when your environment becomes septic.

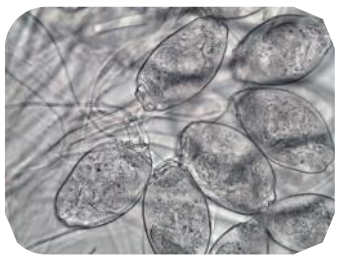
Appling bioaugmentation MicroBlocks, liquid or free flowing powdered bacteria can keep your system clear of these issues. Biological products offer a more efficient alternative to chemicals. They actually degrade the grease and organics at the source while significantly reducing malodors. The bacteria also will help breakdown amines and organics.

When you have tough areas and a lot of FOG build up we suggest starting with Environmental Leverages (MicroClear® 207 bioaugmentation product) mixed in a bucket of water and poured directly on the surface of the grease to clean out this area. It will work, our free flowing powdered product is highly concentrated! Continual dosage will be required weekly, though since there is no source for recirculation and it gets washed out periodically. However, for ongoing maintenance then you can add the slow release MicroBlock™ which hangs below the liquid level, this product will work 24/7 and continue to dose, lasting 30-60 days.

There are tons of issues with collection systems, lift stations, wet wells and wastewater treatment plants. We have staff that can help you with product application. We are always a phone call or email away to assist. With this information you can think of some possible issues that might be going on in your system and a few options that are available to you besides constant maintenance and chemicals. Sometimes a small amount of preventative maintenance or proactive treatment can eliminate some of the repetitive maintenance.

MicroClear 207 for high FOG


MicroBlock Solid for FOG



Did you guess what this was? These are colonial stalked ciliates. When they are dominant, they typically mean a nice medium sludge age. If they have heavy attached growth, it means the system has been stable and they have been in there a long time. They made it in the clarifier, through the RAS, returned quite a few times. If you are targeting a nice medium sludge age, this is a good thing.

October 2017- Stalked Ciliates

Check out our website for more photos of our new mystery bug!!!!

EnvironmentalLeverage.com

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