

The Wastewater Insight



BIOAUGMENTATION TIPS

Bugs

Bioaugmentation. . . I've heard a lot about it but didn't it have the reputation in the past as snake oil?

Yes, we agree with you. In the past there were tons of misconceptions about biological products. There were many companies trying to sell biological products. There were tons of companies trying to manufacture products. There were many names, different types of products, totally different recommendations on dosing and pricing seemed like it was picked out of a hat. Bioaugmentation reps had a worse reputation than car salesmen.



It was perpetuated by the fact that the biological portion of a wastewater system seemed like the mystery black box. Engineers who were comfortable with numbers could evaluate other parts of the system. You could measure flow, pumps, hydraulics, loading, or many other variables in and around a system. Those darn little bugs just did not follow any real math. So many engineers and operators were not really fond of the biological portion of the system. Many times polymers and chemicals were used as Band-Aids to overcome any deficiencies in the biological portion. There was not a lot of easy to follow training on the biological portion of the system either. A lot of the training was at a highly technical level and many operators were overwhelmed at what appeared to be a daunting task to understand what was going on in their system.

Many companies popped up 20-30 years ago selling biological products. Overdosing occurred and was often abused since some of the sales reps could take advantage of the lack of understanding of the biological portion of the system. They assumed the sales rep knew more than they did, believed them and often over purchased products and then were often disappointed in the results.

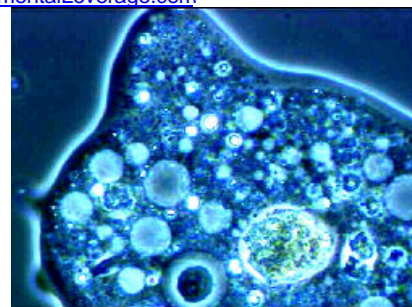
Here are a few quick and easy things to remember no matter where you purchase products from:

- 1- **Bacteria are not cannibals-** they do not eat each other- and technically they will not eat old sludge and completely make it go away. There is a law of matter involved- for every pound of BOD- X amount of lbs. of Biosolids will be created. The ratios may change depending upon the type of industry you are in or your plant process, but these can be used as a quick rule of thumb.

MYSTERY BUG OF THE MONTH

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

Check out our website for more photos of this very interesting organism!!!
WWW.EnvironmentalLeverage.com



Naked Amoeba- they usually indicate young sludge or recent high BOD loading

BOD:Sludge Ratios

Basic Steel (coke):	1.0:0.15
Petroleum Refining	1.0:0.35
Chemical Process	1.0:0.35
Sanitary (Municipal)	1.0:0.3-0.5
Pulp & Paper	1.0:0.5
Brewing	1.0:0.6
Food Processing	1.0:0.7

You can use bacteria in an old sludge lagoon to reduce solids, but it is more a matter of old leftover organic material that has built up and by using selected bacterial products, you can reduce some of the solids to avoid dredging as often. Sooner or later though, all lagoons will need to be dredged. There will be some solids accumulation.

- 2- No matter which bacteria you use, whether you depend on the indigenous bacteria already in your system, or use liquid or dry cultures from a supplier **all bacteria require** a minimum amount of steady conditions we **call the "Critical 5 plus One"**. Bacteria are not Superbugs- they all need these conditions monitored or they will not work correctly.

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Environmental parameters for biological activity including:

PARAMETER	ACCEPTABLE	OPTIMUM
Dissolved Oxygen	>0.5 mg/l	1.0 - 2.0 mg/l
Temperature	50 - 95° F	77 - 95° F
pH	6.0 - 9.0	7.0 - 8.0
Ammonia Residual	1.0 - 3.0 mg/l	2.0 - 3.0 mg/l
Ortho-phosphate Residual	0.5 - 2.0 mg/l	1.0 - 2.0 mg/l

- Residual should be measured in the final effluent.

**Alkalinity is the plus one and is only applicable where nitrification is required.

3- Bacteria can come in many different sizes, shapes or formulations.

There may be dry formulations, liquid, Cubes or Blocks. The reason they are made in different formulations is usually just for ease of application. General rule of thumb, dry products are almost always more concentrated and you get more of the bacterial formulation for your money instead of paying for liquid carrier. You must consider handling concerns and application though when choosing a product. Be careful about biological counts. Numbers are not as important as types- check out handout on evaluation of biological products.



4- Application of bacteria can significantly improve many systems.

Although many believe that there already are bacteria present in a system, so why should you supplement with more bacteria when you can grow your own? That may be true, there are bacteria in a system, but are they the right type

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are
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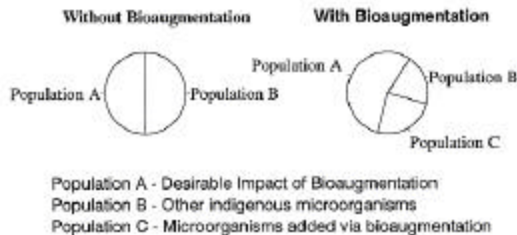


Figure 5: Conceptual Impact of Bioaugmentation on Bacterial Population in an Activated Sludge System

sufficiently achieving what your plant needs to accomplish. If your plant is currently meeting BOD and TSS permits, solids handling is not a problem, there are not filaments or foaming and everything is running the best it possibly can, then no bioaugmentation is necessary.

There is a saying, if it isn't broken, don't fix it. We agree. The only reason to add bacterial supplements is when the plant may be over designed, under designed, having a hard time meeting permits, solids handling costs are too high, grease from lift stations is causing problems, Foaming or filaments are a problem. There has to be a need and a problem that might benefit from the bacteria in order to justify the cost of supplementing a system. If significant returns on investment can be achieved, then bioaugmentation definitely should be looked into.

5- Applications of biological products- Biological products are used for many different reasons.

Some of these may be rapid building of a biomass during a system start-up, recovery from an upset or toxic shock, reseeded after chlorination for filamentous control, reseeded after hydraulic washout. Some may use products for enhancing performance in once-through systems via ongoing supplemental

inoculation. Some areas may include ongoing population enhancement of activated sludge in order to meet permit restrictions such as BOD or TSS. Solids Reduction and handling costs is a growing area that is constantly in need of address even when the plant is running fine on other variables. Filamentous control, foaming, grease reduction are areas where bioaugmentation can be used for short periods of time until process changes can be implemented long term to solve the problems. Under- designed plants or older plants where new growth in a community is faster than building new plants are often applications where biological products are used for only a period of time. Some plants only use biological products during the winter (colder) months when activity of the biomass slows down due to temperature drops (biological activity can drop one log growth for each 10 degrees). Many food or industrial plants that have pretreatment permits use biological permits to lower their surcharges. There are many applications for use of biological products. Make sure the cost justifies the return.

6- Why use biological products when there is always a plant down the street that I can just go borrow sludge from?

The biosolids from a plant are not free- the cost of trucking and handling sometimes are more than the cost of prepared biological cultures. There are no pathogens, filaments, zoogaea, tetrads, inorganic debris or other variables that might be present in sludge from a neighboring plant. With commercial cultures, the products are highly concentrated, stable, and can actually be "grown up" prior to application, which greatly enhances the cost-effectiveness.

7- You cannot buy "higher Life forms" These are indicator organisms. They show up in a system and disappear according to the health and age of the biomass. The bacteria in the system perform 98% of all BOD removal; not the little critters that people often assume are working in the system. See attached sheet on higher life forms evaluation.

8- There are many things to consider when determining biological applications- cost, ease of application, benefits, safety, environmental impacts, permit restrictions, etc. Bacterial products are not black magic, can be easily applied and can significantly improve many situations. Just be sure to check all the variables and don't be afraid to investigate and do some homework! It really is quite easy and they are very efficient if treated properly.

Here are before and after pictures of a Municipal plant that had filaments and foaming problems. Solids were floating in the clarifier due to Microthrix and Nocardia. A brief bioaugmentation program was implemented to reseed the plant after heavy wasting and chlorination.



Here is a Municipal Lift station that uses biological products



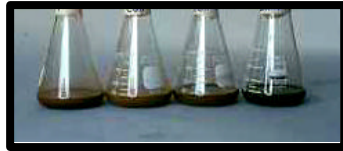
How do I evaluate Biological products?

It is very confusing, one person says his product has 1 billion count product, Another vendor says his product is better because it has 5×10^9 cfu, still a third says his product has "3+ billion per gram viable cell count". What is the difference and what do those terms mean?



It is confusing, how do they all compare?

Well one thing to note- cfu stands for colony forming units. It is a measure of plate counting bacteria to get official numeration of the amount of bacteria present per gram of product.



Make sure the CFU or plate counts are per gram vs. per gallon, per lb, etc. What you are measuring has to correlate to how you obtained the sample, how much of the sample is used and how the results were achieved. Sound complicated, well it can be. Sometimes vendors use plate counts as a "magic number" to wave around and try to out maneuver their competitors.

Numbers are not always as important as the types of bacteria present. We have done years of studies that prove that the number of bacteria present is not as critical as the types of bacteria present. We have found in most wastewater treatment facilities, that it is the Gram Negative bacteria that are better floc formers. Bacillus and Gram positive bacteria do not form as solid of a floc structure.

Both types of bacteria will degrade BOD similarly. But in most treatment plants, BOD as well as TSS is important, therefore, floc structure is very important.

One thing we did when testing and developing products was to perform shake flask tests. **Shake flask studies are conducted** for treatability studies of wastewater samples to reduce overall BOD or to target a specific compound and to improve settling characteristics. It can be used for toxicity studies or for product screening procedures. It is similar to a quick and dirty jar testing for polymers that most people are familiar with but takes a little bit more time and is used to evaluate the performance of biological products.

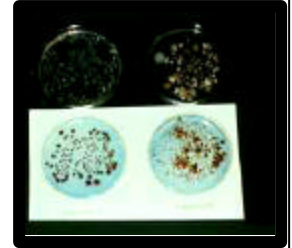


These studies use various strains of bacteria and different supplier's products to test counts vs. types of bacteria present. BOD removal, floc formation, higher life forms present, and TSS were all measurements that were taken into consideration. If plate counts are performed, the number of bacteria, the size and shape of the colonies on the plate as well as the diversity must be taken into consideration. Slime formation on the plates should be evaluated also.



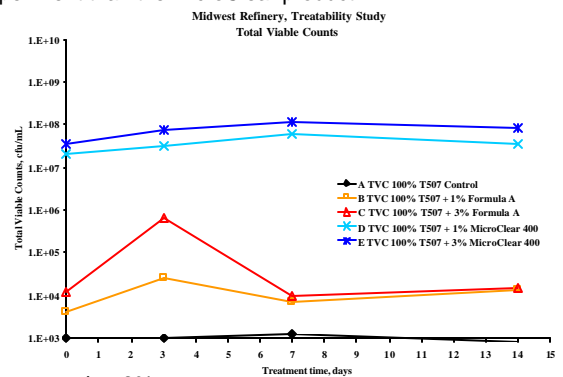
*Note- Sometimes if companies are aware that a product is going to be used for comparison studies between other companies and competitive biological products, they have been known to "spike" the test sample to a higher concentration of bacteria in order for their product to deliver higher results. Be careful what you tell the supplier or make sure that what sample they deliver meets those same specs continually. Hold them to the plate counts on their product if they maintain that this is their normal product quality.

Here is a photo of two sets of plates. One product is mostly bacillus or gram positive bacteria. The set on the right is a mixture with a high blend of Gram negative bacteria and mostly pseudos. The plate on the right, regardless of the initial counts, showed higher growth potential and activity, more natural polysaccharides, which help to form floc and reduce TSS and polymer consumption in final clarifiers.



Here is a two-week trial of our biological product vs. a competitor product. Our product has only a count of 1 billion per gram, but it is mostly gram negative bacteria. Here is a competitor product used at an outside lab in a treatability study. Formula A has a count of 5 billion per gram. This study was run for three weeks.

What you can see from the trial is that even though two sets of flasks were run of each product, a 1% solution and a 3% solution, Formula A had significantly higher counts in the original product, but it could never reach the level of activity that our MicroClear formulation achieved instantly. MicroClear was also able to stay at the higher level of activity throughout the experiment. Formula a peaked at day 3, dropped off at day 7 and stayed at a significantly lower level throughout the entire experiment than the MicroClear product.



Also note, that 3% of Formula A could not reach the level of only 1% of MicroClear in spite of the higher initial counts and in spite of the 3 times the dosage in the 3% vs. 1% flask. This proves that counts on products are meaningless.

Treatability Study Guidelines:

The treatability of the wastewater samples is determined on the basis of

- Relative increase in bacterial counts ($T_{final} / T_{initial}$)
- Decrease in TOC over the 24-hr period.
- Microscopic Examination including
- Number and morphology of floc structures, color, settleability, size and shape
- Quantification of higher life forms- types as well as numbers
- Clarity of the bulk water

Ok, well that example was just a lab test, sometimes field tests may prove to be different. Do you still doubt that the number of bacteria is not as critical as the type of strains? Think of it this way, if you were to chose a basketball team and had 10 guys off the street vs. 5 Michael Jordans- who do you think would give you better results? You do not chose a polymer program based upon actives or molecular count, but on performance, why should you choose your bacterial products based upon numbers?

Still not convinced? Here is a Case History from an actual papermill that was using Formula A. They were using 3-5 lbs of Formula A per day to help them with BOD and TSS removal. We switched them to a dual program with 1 lb of our MicroSolv 118 and one lb of MicroClear M100- a micronutrient formulation. Check out the amazing differences in spite of "lower numbers".



Papermills: Case History with Total System Optimization:

100% Recycle papermill

The first stage of the lagoon was aerated, second and third settling lagoons. Large amounts of algae, scum and duckweed covered the

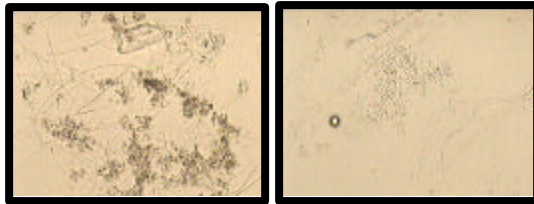
last two stages of the pond. This pond was on a bioaugmentation program for years.

An audit was conducted, recommendations to move one of the aerators to the first half of the second stage were made to allow more oxygen to carry through the rest of the system. Bioaugmentation was changed from 2-5 lbs of product per day from local supplier to 1-2 lbs of MicroClear 118 and 1 lb of Micronutrients.

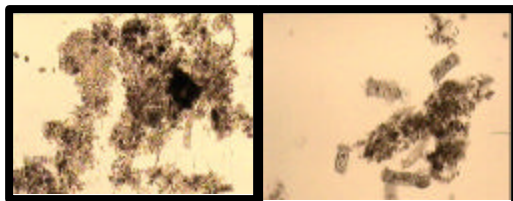
In less than 2 weeks, the scum was gone off the pond, the BOD and TSS removal improved, floc structures increased significantly and higher life activity went sky high. Short, free-floating filaments disappeared. Spirillum (usually an indication of septic conditions) and zooglea were gone after changes in treatment. Some filaments are still in the floc structures, mostly Type 021N, but that is due to solids handling problems in the primary clarifier that are under consideration for optimization.

Prior to Bioaugmentation program changes

Smaller floc with lots of filaments Photos taken at 100x bright field Zooglea and spirillum Photos taken at 400x bright field



After addition of MicroClear 118 and Micronutrients



Large compact floc structures Both of these photos taken at 100x bright field Significant increase in higher life forms, rotifers, less filaments and TSS. The primary clarifier still needs a bit of

solids handling optimization, but the plant is waiting on an additional tank up front to store settled solids that are recycled back into the system. The plant at one point had an upset for a two-week period; twice the loading of BOD was entering the lagoons. The final BOD was still below previous year's final effluent values and way below permit levels!

Additional Comments: If using this for a guideline to compare biological programs and vendors, please take into consideration Total Program value, cost per equivalent product in ratio, evaluations of shake flask testing, BOD/TOC as well as TSS comparisons. Health of the biomass after addition of product, Technical support, training, program consulting, experience and additional corporate back-up are also considerations that need to be accounted for. Many times the EPA can be involved with plants, new permit evaluations, etc. make sure your vendor is capable of providing you these services and recommendations if needed.



2-Day Free Workshops: Emergency Response to Threats of Intentional Contamination of Public Water Supplies

Overview EPA-sponsored workshops to further assist utilities and emergency responders in preparing for threats and potential incidents. **Day 1:** Instructional training on emergency response including an extensive review of EPA's Response Protocol Toolbox, and a discussion of the National Incident Management System (NIMS) -- the protocol for managing public emergencies ranging from accidents and natural disasters to acts of terrorism. The NIMS instruction will focus on the Incident Command System (ICS) and the activation of Emergency Operations Centers (EOCs). **Day 2:** Detailed tabletop exercise centered on an intentional contamination event of a public water supply. The goal of the exercise is to bring representatives of the key response agencies together to apply the guidance provided during the first day of training. **Intended Audience:** The following entities are encouraged to attend: water utilities, FBI, local and state police, emergency responders, EPA, state regulatory agencies, state and local health departments, and elected officials.

Cost: Free with 1.6 CEUs earned.

Training Course or Workshop

Duration: 2 days **Sponsor:** US EPA For

More Information: [Registration and additional informationhttp://www.epa.gov/epahome/exitepa.htm](http://www.epa.gov/epahome/exitepa.htm)
<http://www.epa.gov/epahome/exitepa.htm> about the 2-day course is available.



We have found some very interesting as well as informational websites on the Internet. We hope you enjoy these and we will provide a few more each month! If you have a special request, let us know since we explore the world through the Internet all the time!!

National Environmental Performance Track Program -

Region 4 The U.S. EPA National Environmental Performance Track (Performance Track) is designed to recognize and encourage top environmental performers - those who go beyond compliance with regulatory requirements. EPA encourages facilities to maintain existing participation in other EPA partnership and state programs while joining the Performance Track. <http://www.epa.gov/performance-track/>

COMING NEXT MONTH

Beneficial Reuse in Industrial facilities
Solids Handling and ways to optimize- land application