

BIOSTREME™ MICRONUTRIENT TECHNOLOGY

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Abstract

Micronutrient technologies are just now, after years of technological refinements and in-field testing, beginning to find their place as a remarkably effective and cost efficient performance enhancement solution.

BioStreme™ products are a group of biological waste system additives containing a proprietary blend of organic micronutrients, all of which are biodegradable and completely non-toxic, in a form readily available to microorganisms. With the addition of BioStreme™ products to a waste handling/treatment facility, the biological pathways are no longer inhibited due to the lack of essential nutrients and as a result biological activity, growth and metabolism are substantially increased. By stimulating specific indigenous microorganisms, tremendous benefits in waste treatment can be achieved including a considerable increase in treatment efficiency, odour control along with substantial operational cost savings.

BioStreme™ micronutrient technology yields remarkably effective and cost efficient performance capabilities in almost any naturally occurring biological process. Principal research, corresponding field studies and in-country commercial sales have been wastewater related.

For the past three years considerable research has been conducted in the design and effectiveness of engineered formulations of micronutrients on indigenous biological species beneficial to wastewater treatment. In Australia product is being used in small commercial sewage plants and a successful retail product range for the domestic AWTS, septic, and pit toilet applications.

Keywords

BioStreme™, Enviropro, micronutrients, odour, sewerage, waste

1 Background

Globally, the wastewater treatment industry is undergoing dramatic changes. Increasing pressure by environmental lobbyists and an elevated concern for public health and safety is forcing governments and the general population alike to re-position their role in the governing and maintenance of wastewater operations.

Enviropro Alternatives Pty Ltd, in cooperation with a Canadian research and development company Hydra-logic Systems Inc., has developed and markets a range of micronutrient formulations for use within the residential, commercial and industrial wastewater industry. Micronutrient technologies are just now, after years of technological refinements and in-field testing, beginning to find their place as a remarkably effective and cost efficient performance enhancement solution.

2 Technology Profile

The use of biological processes for the treatment and/or remediation of wastes is now an established method of reducing the impact of both industrial and municipal pollutants on the environment. In any biological process, from septic systems to large-scale treatment plants the fundamental components of the degradation process are the various bacteria. As such, effective management of the existing biological population is essential to the proper operation of these systems.

In many biological processes the existing biological population consists of several different species of bacteria, many of which are not strict obligate aerobes or anaerobes, but rather can function in both aerobic and anaerobic environments. These microorganisms, called “facultative microorganisms”, synthesize organic material without producing odorous by-products and are typically the major contributor to the stabilization of waste and wastewater.

Facultative bacteria, like any living organism, have specific nutrient and micronutrient requirements for optimal growth and reproduction, many of which may not be present or in a readily available form in conventional waste streams. This situation can often become a rate-limiting variable in the processing of wastes resulting in decreased operating efficiencies, loading rates and/or undesirable by-products such as excessive odours, scum formation and solids.

In addition to the many essential micronutrients, microorganisms also require organic nutrients. These organic nutrients are sometimes known as “growth factors” and are compounds necessary for organic growth because they become constituents of organic cell material that cannot be synthesized from other carbon sources or the waste. Growth factor requirements differ from one organism to another, but the major ones fall into the following three classes of constituents found in BioStreme™: amino acids, purines and pyrimidines, and vitamins.

BioStreme™ products are a group of biological waste system additives containing a proprietary blend of organic micronutrients, all of which are biodegradable and completely non-toxic, in a form readily available to microorganisms. With the addition of BioStreme™ products to a waste handling/treatment facility, the biological pathways are no longer inhibited due to the lack of essential nutrients and as a result biological activity, growth and metabolism are substantially increased. By stimulating specific indigenous microorganisms, tremendous benefits in waste treatment can be achieved including a considerable increase in treatment efficiency, odour control along with substantial operational cost savings.

The ingredients in BioStreme™ have been carefully selected to complement the nutrients and trace elements normally found in natural waters and wastes. Regular use of BioStreme™ ensures robust growth and high performance from your waste treatment facility.

3 BioStreme™ Bio-Chemical Details

BioStreme™ is a complex, genetically derived micronutrient formula that, together with process control modifications specific to your facility, provides a variety of benefits to wastewater microorganisms. Benefits, such as elimination of hydrogen sulphide and volatile fatty acid odours, increased reproduction of facultative anaerobes, carbon oxidation, nitrification, denitrification, dissolved oxygen, coagulation, flocculation, settleability and reduced sludge volume index all may be found with the application of BioStreme™.

3.1 Increased Dissolved Oxygen

BioStreme™ supplies essential growth nutrients to a variety of wastewater microorganisms; facultative anaerobes, strict anaerobes and aerobic bacteria, including protozoa. When the nutrient is added to a facultative lagoon, its impact is noted first on the facultative anaerobes and strict anaerobes, which rapidly multiply. These by-products of fermentation are primarily carbon dioxide and nitrogen gas bubbles on the water surface. The increased carbon dioxide gas and nutritional factors of BioStreme™ cause a rapid increase in algae population (*Chloraccum*). It is the increased algal population rates that produce increased dissolved oxygen to the treatment basin. During day light hours, oxygen levels can reach 8 mg/L and as much as 10 mg/L in primary oxidation basins by 9:00 AM with no mechanical aeration equipment. As the algal population increases, so do *Daphnia*, a fresh water crustacean, which aggressively graze on algae, keeping their population properly balanced.

3.2 Carbon Oxidation

Adding BioStreme™ to aerated basins or aerated lagoons increases carbon oxidation, particularly if aeration is turned off on regular intervals. Facultative anaerobes can quickly reproduce and respond to increased nutrient loads preventing or reducing any toxic shock.

3.3 Denitrification

Oxygen is removed from nitrate nitrogen by *Nitrobacter* in anoxic environments (water containing less than 1 mg/L dissolved oxygen) *Nitrobacter* removes and utilizes oxygen attached to the nitrate- nitrogen molecule to meet its oxygen requirement and nitrogen gas is released to the atmosphere. Nitrogen gas is a harmless ingredient of the air we breathe.

3.4 Sewage Odours

Hydrogen sulphide (H₂S) is a common odour associated with both municipal and industrial wastewater treatment. Volatile fatty acids are also odours common to wastewater and can be more offensive and widespread than hydrogen sulphide, particularly with high strength food processing waste. BioStreme™ promotes high rate reproduction of all key facultative anaerobes, which are biologically incapable of producing hydrogen sulphide gas and out-compete reducing bacteria.

Volatile fatty acids are a fermentation by-product of carbon reduction and oxidation. BioStreme™ enhances the rapid fermentation of *Lactobacillus*, which does not produce volatile fatty acids. BioStreme™ will fully eliminate or greatly reduce all sewage odours provided some measure of oxygen, either dissolved in water or combined, such as nitrate or sulphate, is available.

BioStreme™ products work to *reduce* the formation of hydrogen sulphide by “offering” the sulphur-reducing bacteria an alternative, more “enticing” source of oxygen and complex metabolic aids. The sulphur reducing bacteria actually prefer to source oxygen from nitrates (which are oxides of nitrogen), because it requires less effort from the bacteria. Nitrates may be naturally present in some wastewaters and BioStreme NTX can be used to compensate for deficiencies. When sulphate is replaced by nitrate, the following equation may represent the reaction that occurs:



The by-product of this reaction is nitrogen rather than sulphide. The nitrogen can even be “fixed” by nitrogen-fixing bacteria in a well developed ecosystem back into nitrate-nitrogen to be re-used by additional bacteria for the metabolism of more organics (carbon) in the system, thus decreasing the overall level of solids.

The majority of the reduction reactions occurring in the sewer lines take place on the surface of pipes in a layer of organic biomass. Dissolved oxygen in the wastewater flow will be toxic to obligate anaerobes (reducing bacteria) so that they tend to use the biomass slime as a buffer against contact with the oxygen containing water. Metal salts are not effective in breaking down the slime layer resulting in continued corrosion on the backside of the sewer pipes. BioStreme™ NTX promotes rapid propagation of facultative anaerobes in the waste stream. When this occurs, the slime layer is quickly broken down biologically; reducing the potential for corrosion, and any available dissolved oxygen may be utilized in oxidation reactions as well.

3.5 Solids Degradation

Volatile suspended solids (VSS) contained in wastewater influent and VSS contained in dead wastewater bacteria that settle to the bottom of treatment basins will accumulate unless dissolved by hydrolysing enzymes produced by strict anaerobes and facultative anaerobes. Specific nutritional factors supplied by BioStreme™ increase production of hydrolysing enzymes and have successfully reduced solids in a variety of wastewater treatment systems since 1977, including waste from dairy cattle, pulp, food processing, municipal and oil contaminated soils.

BioStreme™ has been successful in removing solids build-up in sludge basins in dairy cattle operations, pulp and paper and municipal treatment facilities. BioStreme™ was used at a California wastewater treatment plant where VSS in the aerobic digester were reduced to 32% and total suspended solids were concentrated to 18%. Normal digested solids at 18% TSS would be so thick that it would not flow through a pipeline, yet the 18% solids at the Strathmore treatment plant, flow as easily through a pipeline as 2% digested sludge. This is due to the high inorganic solids relative to low organic solids, e.g. Ash does not hold bound water.

Aerobic digesters can also benefit by the addition of BioStreme™ by turning off aeration on regular intervals. This will allow fermentation bacteria to develop and produce enzymes capable of dissolving the membranes of dead activated sludge organisms. This will significantly reduce VSS and increase TSS concentration, thus increasing the effective working capacity of the digester by more than double. Additional benefits are elimination of odours, reduction in power usage and in total sludge processing costs.

3.6 BOD₅ and Suspended Solids Reduction

Activated sludge treatment processes, trickling filters/bio-towers, rotating biological contactors (RBC's), aerated basins and lagoons and other aerobic processes all rely on bacteria to degrade organic compounds. Bacteria must first make contact with organic compounds contained in the water and then they secrete an enzyme capable of dissolving the ingredient. Once the compound is hydrolysed it can be absorbed and pass through the membrane of the bacteria. Bacteria are so small they cannot be seen by the naked eye and are so light they cannot settle in water. Larger wastewater microbes such as protozoa feed on bacteria and with the aid of floc-forming polymers produced by the biomass, are capable of settling and clarifying water, thus removing BOD₅ and suspended solids from the final effluent.

4 Applications

BioStreme™ micronutrient technology yields remarkably effective and cost efficient performance capabilities in almost any naturally occurring biological process. Principal research, corresponding field studies and in-country commercial sales have been wastewater related.

Wastewater Treatment

Supplementing wastewater treatment facilities with BioStreme™ can provide significantly improved plant performance and reduce the production of nuisance odours including hydrogen sulphide and ammonia. BioStreme™ can provide interim optimization of existing biological wastewater treatment processes thereby improving hydraulic and/or organic loading capabilities.

Wastewater treatment systems that can benefit from the use of BioStreme™ application include:

- Aerated Lagoons
- Biological Filters
- Secondary Clarifiers
- Aeration Tanks
- Facultative Lagoons
- Septic Systems
- Aerobic or Anaerobic Digesters
- Anaerobic Lagoons
- Trickling Filters
- Rotating Biological Contactors
- Primary Clarifiers
- Holding Tanks

5 Research and Field Projects

HydraLogic's founders have spent nearly twenty years actively engaged in the study and practice of developing technologies designed to optimize the naturally occurring biological processes in wastewater treatment environments. The process and formula outlined in this paper have been refined over the years to a level of performance, which is both remarkably effective and extremely cost efficient.

For the past three years considerable research has been conducted in the design and effectiveness of engineered formulations of micronutrients on indigenous biological species beneficial to wastewater treatment. Most recently, HydraLogic has initiated considerable work throughout North America in the areas of pulp & paper and municipal sewer works. Successful large-scale treatment pilots achieved performance and financial targets in the reduction of hydrogen sulphide production and corrosion control in a large Southern US municipality. Additionally, cooperative research in the design of the formula and ultimately the effectiveness in pulp and paper wastewater applications are being carried out in the province of Quebec, Canada as well as the Netherlands. Research partners include a prominent Canadian university; industry recognised engineering consultants and that country's National Research Council.

In 1996 EnviroPro Alternatives Pty Ltd began working in conjunction with the Canadian developers of BioStreme™ to reach the Australian wastewater market. Retail products based on BioStreme™ have been developed for the domestic market, in particular for septic tanks, AWTS, composting toilets and portable toilets.

The most popular product – SSR (Septic System Revitaliser) has made a pronounced impact and produced excellent results. Septic systems, which had been struggling with foul odour, excessive sludge and blocked absorption trenches, have settled down and function at peak

performance. Odours normally are gone within seven days and trenches in many instances will begin working properly again after 30 days.

There is also a reduction in the sludge volume within the system.

In addition, EnviroPro has been working with smaller commercial sewage plants. The effectiveness of BioStreme™ can be seen in the improved performance of these plants.

Case Study

In one particular situation there was a major problem with odour and difficulty in conforming to the EPA's requirements for discharge. Within five to ten days of introducing the BioStreme™ treatment program there was little to no apparent odour coming from the either biological unit or the lagoon.

As shown the ammonia, BOD, total grease, phosphorus, and TSS levels decreased noticeably until it reached equilibrium

Unfortunately due to the nature of this type of biological plant, slightest change to the process's environment upsets its efficiency. If you take the latest results shown, they show there has been an upset to the process, in this case it was found that the cleaning contractors had changed the type of chemicals they were using, i.e. not suitable for this type of process, killing the facultative bacteria. It is our belief that the BioStreme™ product was helping to prolong the aerobic process until finally the biological unit could not cope and started to change to anaerobic, therefore odours returning.

Following the trend of testing results over the past three years, when there has been evidence of the biological unit or lagoon straining to cope, it coincided with a high population loading or unforeseen equipment problems. It has been found necessary to go back to dosing the BioStreme™ product in to both the small sewage tank and main sewage tank sump wells to bring the system back on line.

Tables 1 through 4 give the percentage reductions in ammonia, BOD, total grease and TSS over the first three, six, twelve and eighteen months.

Table 1: Ammonia

AMMONIA AS N (mg/L)	OUTLET OF BIOLOGICAL UNIT	POND WATER
3 months	Negative reduction 5%	30%
6 months	Negative reduction 22%	Negative reduction 10%
12 months	33%	Negative reduction 30%
18 months	28%	Negative reduction 70%

Table 2: BOD₅

BOD ₅ (mg/L)	OUTLET OF BIOLOGICAL UNIT	POND WATER
3 months	18%	36%
6 months	62%	50%
12 months	36%	59%
18 months	79%	77%

Table 3: Total Grease

TOTAL GREASE (mg/L)	OUTLET OF BIOLOGICAL UNIT	POND WATER
3 months	63%	73%
6 months	73%	>77%
12 months	>32%	>77%
18 months	>32%	>77%

Table 4: Suspended Solids

SUSPENDED SOLIDS (mg/L)	OUTLET OF BIOLOGICAL UNIT	POND WATER
3 months	Negative reduction 5%	51%
6 months	44%	37%
12 months	110%	80%
18 months	94%	73%

6 Conclusion

BioStreme™ micronutrient technology will enhance most wastewater treatment situations. In doing so it will improve the plant's flow handling capabilities, reduce unwanted odour, reduce solids accumulation and effectively lessen energy costs by reprogramming plant aeration levels.