



BIO-ORGANIC CATALYST
THE POWER IN NATURE®

CASE STUDY

bio-organic.com

Engineered Wetland Environmental Enhancement



Naturally Accelerated Pollution Treatment

Bio-Organic Catalyst

Engineered Wetland Environmental Enhancement

Introduction:

Engineered wetland systems have proven to be an effective, sustainable, reliable, and economical treatment method for sewage and organic industrial waste. These wetland treatment systems are self-contained, artificially engineered wetland ecosystems designed in various ways to biologically reduce organic pollution, including but not limited to; sewage, agricultural slurries, industrial wastes, fisheries, dairy facilities, mines, hydrocarbons and glycol plus many other pollutants from different sources. Contaminated wastewater flows through and is purified by the actions of bacteria, fungi and algae (micro-organisms) that digest the pollutants, the variety of plant life chosen is also important. These engineered systems are designed to optimize the microbiological, chemical, and physical processes naturally occurring in the wetland to be able to effectively degrade pollutants to a non hazardous level before discharge into the environment.

This paper explores the introduction of Bio-Organic Catalyst (BOC) to engineered wetland treatment systems including forced bed aeration for the purpose of optimized pollution reduction, enhanced biological health of the ecosystem, extending the operational lifespan of engineered wetlands and reducing the physical footprint of systems. BOCs bring critical solutions to the fundamental challenges of treating difficult wastewater components within all wastewater treatment systems.

The following parameters are discussed in this paper. Total nitrogen reduction, biochemical oxygen demand (BOD), chemical oxygen demand (COD), increased carrying capacity, biological health and diversity, FOG treatment, sludge reduction, reduction of mineralization build-up, total suspended solids (TSS), clogging, bio-film, ammonia reduction, phosphate reduction, odors, cold climates, forced bed aeration, extending operational lifespan, and improving dissolved oxygen levels.

BOC is a new sustainable product line that is used in multiple industrial, municipal and agricultural applications worldwide. The Company's bio-catalytic compositions (BOC) is a proprietary, patented liquid product that is directed at solving the most critical aspects of improving water quality and related biological challenges. (BOC) compositions provide a new technology platform un-matched globally in their ability to eradicate organic pollution, and provide eco-friendly solutions in industrial cleaning, petroleum hydrocarbon remediation, odor control, wastewater treatment and purification systems worldwide.

Engineered Wetland Environmental Enhancement

Concept:

We believe in natural and environmentally safe solutions to pollution treatment. The BOC technology we provide for wetland applications offers several unique benefits that no other product available can achieve for environmentally safe pollution treatment enhancement.

The concept of engineered wetlands as a pollution treatment system is to offer a natural chemical free and simple method to deal with our waste generated by mankind. Manufactured chemicals are generally considered pollutants to the natural ecosystem therefore unwanted in a natural waste treatment system. BOC is not considered a traditional chemical and is 100% beneficial to the ecosystem. The advanced green technology and well established safety profile of BOC allows for its safe and highly beneficial introduction to an engineered or natural ecosystem to accelerate the biological reduction of pollutants by up to 100 times, providing the ability to increase loading or decrease land space traditionally required to process specific levels of influent . BOC can also be used to enhance the biological integrity of existing systems to deal with excess loading and improve effluent quality. BOC also specifically targets some of the most difficult organic pollutants like FOG and hydrocarbons (BTEX).

The introduction of forced bed aeration to engineered wetlands for accelerating biological pollution reduction is a good example of technology application to enhance the natural pollution processing abilities of the wetland. BOC is the next technology advancement for the industry to enhance pollution reduction even further. Working under the same philosophy BOC enhances any of the common designs of constructed wetlands such as: free water surface (surface flow, or open water), horizontal subsurface flow (vegetated submerged bed, root-zone or rock-reed filters), vertical flow systems and forced bed aeration systems, (Scott D.Wallace, P.E) When BOC is introduced to a forced bed aerated system energy consumption is reduced by 20 to 35% and significantly increases effluent quality. Accelerated pollution treatment through environmental enhancement with Bio-Organic Catalyst opens up many new opportunities for the industry to expand beyond its present boundaries.

BOC is a unique “green” technology that’s quickly advancing worldwide as a multipurpose safe tool to reduce organic pollution and purify water.

Introducing BOC to an engineered wetland system provides the following benefits:

Environmental:

Increased effluent quality, reduced carbon and land footprint.

Sustainability:

Ensuring the ecological balance and health of wetland systems.

Physical:

Reduced land space required, clogging is avoided or extended exponentially.

Economic:

Reduced land space required, environmental compliance, increased market share, reduced energy consumed.

Biological:

Biological integrity of the system is enhanced exponentially increasing processing ability.

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BOC Technology Overview:

The Company's bio-catalytic composition (BOC) offers a new technological platform within the traditional water treatment and cleaning chemical marketplace. The BOC products are all based upon a breakthrough technological understanding of how to unlock the inherent transformation power of natural biological pathways. The rate of gas (oxygen) transfer is critical to all aerobic biological processes. Breaking molecular bonds and releasing pollutants into more digestible form for microorganisms to consume as a food source.

The BOC product line is built upon the powerful bio-catalytic capabilities of a fermentation supernatant, derived from plants and minerals, which is then blended into a very powerful bio-catalytic liquid concentrate which when diluted into water creates highly self-organized and ultra-fine micro-bubbles that provides superior oxygen transfer into the water column allowing an acceleration of biological and chemical reactions within organic wastes and sewage filtration. These ultra-fine micro-bubbles have very high gas (oxygen) transfer characteristics. More available oxygen enables an accelerated rate of the natural biological degradation processes and faster aerobic reactions. Improved gas transfer rates adds improved conversion of insoluble organic waste components, along with enhanced maximum utilization of molecular oxygen, makes this revolutionary bio-catalytic chemistry vastly important to a broad array of environmental and waste conversion objectives.

BOC works on multiple levels:

- As a molecular oxygen enhancer providing support (increased oxygen transfer) throughout the wetland.
- As a catalyst that provides support to the biological communities through an accelerated reactive breakdown of organic compounds within the waste stream, turning difficult waste components like FOG and hydrocarbons into a high energy food source for bacteria on contact.
- BOC provides an environmental cleaning action within the wetland, controlling excessive bio-film buildup along with an accelerated breakdown of organic material thus preventing clogging, reducing maintenance and extending the life span of the system exponentially to indefinitely.

The integration of Solubilization, Oxidation and Catalysis (S – O – C) provides for the first time a universally applicable biochemistry platform that addresses the need for a complement to existing chemical and biological processes, an ability to eliminate or substantially reduce toxicity in waste management, and strong economic values in reducing waste management treatment costs. The formulations work by creating a nearly instantaneous catalytic breakdown of organic molecules, making them more readily digestible by indigenous bio-organisms, as well as more rapidly oxidized by chemical agents. Rather than attempting to break down specific organic elements, as an enzyme would do, a broad cascading action is created, accelerating biological degradation throughout the entire spectrum of organic contaminants.

This breakthrough technology provides many benefits throughout all aspects of water treatment and cleaning applications. BOC solubilizes organic materials, increasing the nutrient availability for indigenous bacteria and reducing the volatile organics for odor control. BOC improves aeration efficiencies, thereby enhancing biological activity. BOC accelerates ionic interactions, helping inorganic oxidation reactions and making nutrients more available to bacteria. BOC activates biomass and increase biodegradation, including petroleum hydrocarbons, within a shorter period of time, and at a lower cost. BOC is the only cleaner that also accelerates the biodegrading of residues being cleaned. The increased oxygen availability, higher dissolved oxygen levels and enhancement in the solubility of cellular material, lead to significantly faster molecular interactions and creates an immediate catalyzing effect on contaminants. This unique ability of BOC to rapidly degrade contaminants into their more fundamental components combined with its proven environmental safety where contaminants are not only removed, they are also degraded into their base components, and hence are more easily eliminated. The introduction of BOC leads to a whole new technology platform for engineered wetland pollution treatment systems.

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The following information is based on studies performed in municipal and industrial wastewater treatment facilities.

- BOC establishes the conditions for rapid oxygen penetration into the cell wall of microorganisms, which cannot occur by mechanical means, thereby reducing electrical costs and optimizing oxygen transfer.
- BOC increases the volume of biogas yields in anaerobic digestion system through increased solubilisation of components of waste stream and providing the bio-available nutrients required for full optimization of methanogenesis.
- BOC significantly enhances the ability of a conventional activated sludge treatment to reduce the Total Nitrogen (TKN) discharges.
- BOC breaks down organic binders and biological film growth, improving healthcare safety, reducing contamination and corrosion problems in industrial applications, and breaking down mineralization within pipes and filters.
- BOC solubilises the molecular structure of organic contaminants, such as fats and greases (FOGs) to carbon, making it more available to the heterotrophic microorganisms as a food source.
- BOC has shown a superior capability to eliminate the conditions that produce noxious odors, including hazardous volatile organic compounds (VOCs).
- BOC has shown the ability to substantially speed up the remediation rates of petroleum hydrocarbons through solubilisation of the TPH components and dramatically increase the populations of indigenous microorganisms.
- BOC provides economically compelling benefits to environmental professionals, bringing practical and cost saving advancements to wastewater treatment, water clarification, industrial and commercial cleaning.
- BOC offers substantial operational optimization in aquaculture, agriculture, biological film control, mineralization, and hydrocarbon remediation applications.

Competitive Advantages:

The superior performance and broad applicability of BOC over traditional chemical agents, or biologically derived products, provides profound competitive advantages in the current marketplace. BOCs patented bio-organic catalysts have the ability to exclusively meet the key performance objectives now faced by facilities management, such as nitrogen discharge reduction, increased carrying capacity, FOG treatment, sludge reduction, higher aeration capability, reduction of mineralization build-up, and reduction of total discharges.

Convenience and Versatility in Multiple Applications:

The integrated nature of BOC products, combining multiple catalytic process elements, provides extraordinary versatility in application. While the actual process mechanism is founded on complex biochemical interactions, the methods for use are quite simple and do not represent a barrier to product acceptance.

Significant Performance:

BOC products offer customers a means to achieve superior performance objectives, often improving the fundamental economics of the applicable process.

Efficacy:

BOC products have independently demonstrated broad and significant efficacy in process and application enhancement. In the wastewater operation, it can reduce energy usage up to 40% and sludge disposal/treatment volumes up to 30%, eliminate odors, clean FOG accumulation in lift stations, and help facilities reach regulatory discharge requirements.

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Non-Toxicity:

BOC products are non-toxic, non-caustic, non-corrosive, non-irritating, hypoallergenic, bacteria-free and biodegradable, BOC is also safe to use in any marine or fresh water environment. The environmentally friendly features of the products substantially reduce exposure and liability to the user, its workers and the environment, and don't trigger costly OSHA or hazardous material handling requirements.

The BOC compositions have been extensively tested in numerous engineering studies and toxicity testing programs. Our products meet U.S. Environment Protection Agency and U.S. Department of Agriculture safety requirements. NONTOX oil spill cleanup product is listed with the EPA, The United Nations Environmental Programme presented BOC as a selected new environmental technology for the developing world markets. The TUV Rhineland Institute for environmental protection and energy Technology tested and documented the safety and effectiveness of BOCs, allowing our compositions to be imported into the highly regulated EU markets.

Bio-Organic Catalyst, Inc. received a 2005 Frost and Sullivan Product Innovation Award for Advanced Catalysts, which recognizes a company's research and development program that has, or is expected to, bring significant contributions to the industry in terms of adoption, change, and competitive posture.

Engineered wetland enhancements:

The following includes benefits and methods that BOC offers to engineered wetlands:

- BOC enhances bacterial proliferation that accelerates pollution reduction
- BOC enhances oxygen transfer through the formation of micro-bubbles and provides a greater dispersion of oxygen throughout the water column
- BOC eliminates clogging in the filter media
- BOC increases system efficiency during cold weather
- BOC optimizes natural self cleaning of the entire system (shutdown and bed cleaning is avoided)
- BOC Reduces the amount of energy required for biological or chemical reactions to occur, then participates repeatedly in these reactions while reducing the time and rate required for turnover (accelerates nature's degradation process up to 100-fold faster)
- BOC solubilises the cellular structure of organic waste, thereby increasing gas transfer rates, and making it easier for naturally occurring bacteria to metabolise organic substances
- BOC offers an accelerated aerobic biological breakdown of the organic loading (BOD/TKN)
- BOC Reduces Volatile Organic Compounds (Hydrogen Sulfide, Ammonia, Amines, Ketones and Mercaptans)
- BOC Reduces BOD (Biological Oxygen Demand), TSS (Total Suspended Solids) and COD (Chemical Oxygen Demand)
- BOC Offers increased treatment capability without the physical expansion of the engineered wetland or further infrastructure investment
- BOC provides the ability to decrease land space required to process influent thus changing the parameters of the engineered wetland technology, making it available to customers with small tracks of land

Engineered Wetland Environmental Enhancement

How the natural bio-cycle works:

When Bio-Organic Catalyst is introduced into the engineered wetland system it initiates a complex interlinking series of events, which provides an accelerated recovery of the eco system. BOCs are non-toxic and are an eco friendly, cost efficient solution for the most common problems with water pollution.

The active properties of BOC work in conjunction to create synergetic responses from nature's self-cleansing system.

Degradation of pollutants is the key to the biological cycle of life, and thus ecological restoration, in nature. The most important aspects of this bio-cycle in respect to pollution are; the bio-availability of the pollutant to beneficial bacteria, and the availability of oxygen that supports biological activity.

The catalytic properties that make BOC a very effective tool in water restoration are its three mechanisms of action.

The Bio-Organic Catalyst Mechanisms of Action:

Catalysation:

Reduces the amount of energy required for biological or chemical reactions to occur, then participates repeatedly in these reactions while reducing the time and rate required for turnover (accelerates nature's degradation process 100-fold faster)

Solubilisation:

BOCs solubilise the molecular structure of organic contaminants by breaking the bond that holds them together, which makes it more bio-available to naturally occurring biology. Contaminants such as fats, oils, grease, petroleum products and fertilizers are broken down to their constituent parts, making them more available to the heterotrophic microorganisms as a food source.

BOCs establish the conditions for rapid oxygen penetration into the cell wall of the microorganisms, which cannot occur by mechanical means, thereby increasing biological activity.

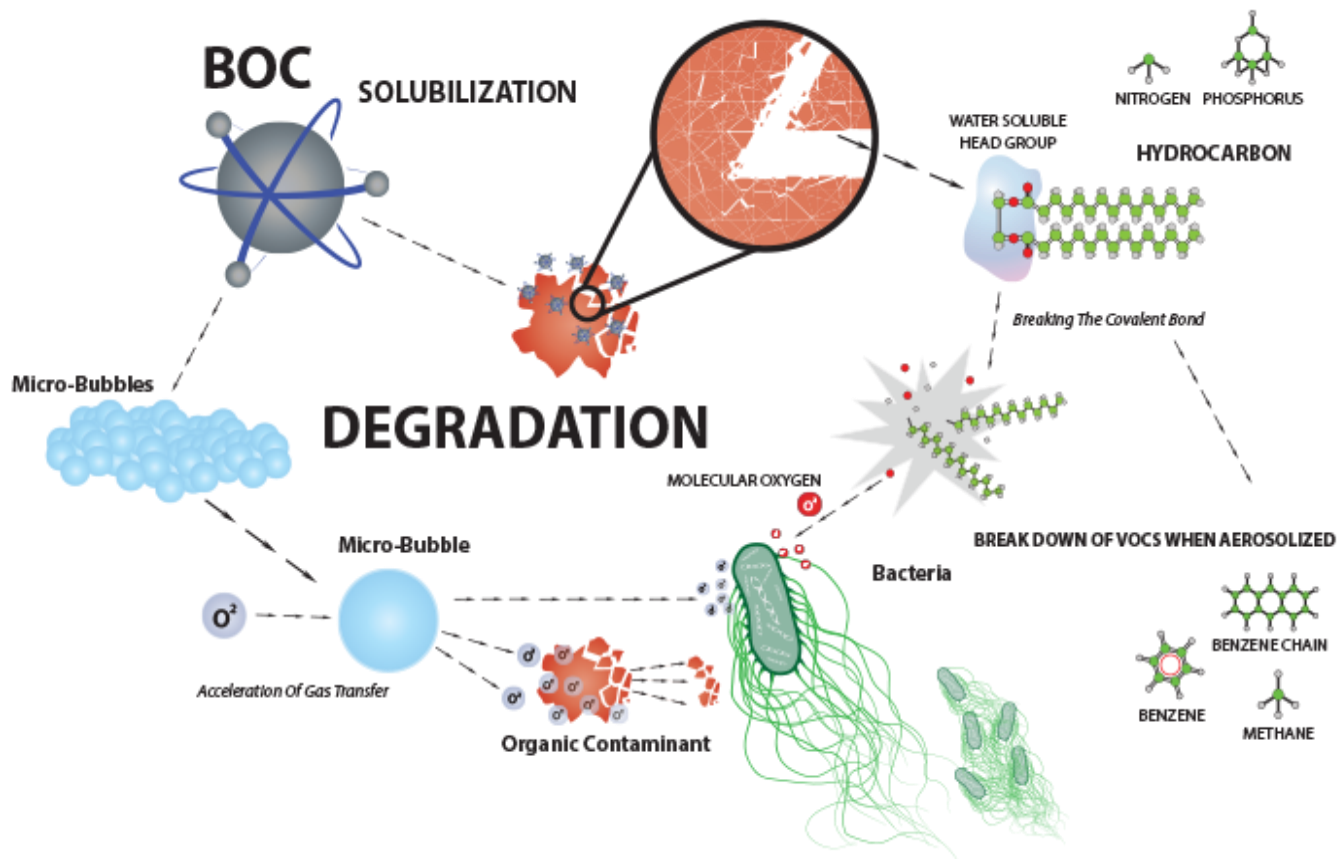
Oxygenation: (Higher aeration capability)

BOC Seeds the formation of micro-bubbles that acts as a platform for biological and chemical reactions to occur creating a stable, time-delivered system to disperse oxygen throughout the water column thereby increasing the availability of oxygen. More available oxygen enables aerobic reactions that will speed up the natural degradation process, while improved gas transfer rates improve both the conversion of insoluble organic waste components to carbon, and enhance maximum utilization of molecular oxygen.

BOC Micro bubbles are more flexible and much smaller than bubbles produced mechanically in wastewater aeration tanks and aquaculture industries. BOC Micro bubbles have a thinner boundary layer and are slower rising in substrate and in greater numbers, allowing for more contact time within substrate producing higher oxygen transfer creating a more oxygen rich environment. . BOC solubilises the cellular structure of organic waste, thereby increasing gas transfer rates, and making it easier for naturally occurring bacteria to digest organic substances. This process of oxygenation and Solubilisation greatly improves degradation of organic compounds and promotes the exponential growth of indigenous beneficial bacteria by using the power of nature

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Bio-Organic Catalyst Mechanisms of Action



Forced Bed Aeration:

Engineered wetlands using forced bed aeration has proven to successfully accelerate the bioremediation rates of pollutants, demonstrating excellent removal rates of petroleum hydrocarbons and at considerably greater rates than non aerated wetlands. The purpose of Forced bed aeration is to provide the necessary conditions that enhance the bioremediation rates of pollutants by increasing biological efficiency with increased available oxygen. Working under the same philosophy the introduction of BOC is simply the next evolution in wetland pollution treatment. BOC enhanced forced bed aeration treatment for high concentrations of organic pollution specifically petroleum hydrocarbons including benzene, toluene, ethylbenzene and xylenes (BTEX), ammonia, ethylene & propylene glycol, and fertilizers.

We estimate wetlands with BOC enhanced forced bed aeration would successfully complete bioremediation of high concentrations of hydrocarbons and other organic pollutants in 50% or less traveled distance than normally would be seen through the wetland, (processing rates of hydrocarbons are accelerated by up to 100 times depending on BOC dosing (PPM) and system design). This creates opportunities and benefits for operators and wetland engineers. The ability to increase loading in existing systems without infrastructure investment is a very attractive benefit for operators. With a BOC enhanced forced bed aeration treatment system in place, land space traditionally required is greatly reduced, this offers opportunities for industries or housing developments with reduced land space that was previously unable to install a traditional design of system.

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FOG and Hydrocarbons:

The remediation of FOG and hydrocarbons is accelerated up to 100 times through the following mechanisms of action;

First, BOC solubilises the FOG and on contact into harmless by-products such as glycerol & fatty acids.

Second, the solubilised lipids are prevented from accumulating on surfaces. This solubilisation is part of a sequenced process in which lipid ester bonds are instantaneously cleaved, reducing the molecular structure to glycerol and fatty acids. Glycerol is water soluble and readily degradable by naturally occurring micro organisms in an established wetland system. Essential fatty acids, released from the lipids, can then be metabolized through the biological processes as a high energy food and source of carbon for nitrification reduction processes.

Third, The most toxic and insidious elements of petroleum hydrocarbon pollutants (TPH) are the generally invisible and rapidly diffused light volatile components, as they are absorbed within the metabolisms of living species and either kill, or mutate, the populations at levels they are unable to tolerate. These pollutants have been shown to be particularly responsive to bio-catalytic reduction, with instantaneous effectiveness, and substantial bioremediation accomplished within hours.

The safety and economy of using bio-catalytic compositions surpasses any alternative chemistry, or biological additive, in addressing the primary challenges and underlying ecological restoration mechanisms that are required to mitigate FOG and hydrocarbon pollutants in waste-water.

Benefits include:

- Immediate reduction of soluble TPH compounds in water bodies and soils
- Immediate rise of flash point to render fuels unable to ignite
- Accelerated remediation of TPH pollutants
- Stimulation of indigenous microbiological populations and vitality

Technology Discussion:

The fats and oils produced by plants and animals are described as lipids. The term lipids, describes all substances that are:

- Relatively insoluble in water, but soluble in organic solvents such as benzene, chloroform, acetone, and ether.
- Related either actually or potentially to organic compounds such as fatty acid esters, fatty alcohols, sterols and waxes.
- Usable as a source of energy and carbon to support the metabolism of a variety of different organisms.

The most abundant neutral fats in nature are the triglycerols (triacylglycerol) with a fatty acid attached to each of the three hydroxyl (OH) group of glycerol. Triacylglycerol is very insoluble in water and, as a consequence, cannot be degraded by wastewater treatment microorganisms until it is broken down into its components; glycerol and fatty acids. The ester bond, linking glycerol to fatty acids, is subject to cleavage by hydrolysis, which can be accomplished by very low pH, very high pH, or by the activity of BOCs, which are also capable of cleaving ester bonds.

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FOG and Hydrocarbons Continued:

Lipases are a specific group of enzymes, which initiate the first step in the breakdown of lipids by cleaving the ester linkage between glycerol and fatty acids. There are also non-specific esterases that can attack the ester bonds present in a variety of organic molecules, including some lipids.

A few substances with an esterase activity are not an enzyme in the conventional sense, but still have the ability to reduce the energy required to cleave an ester bond by hydrolysis. These substances are called Bio-Organic Catalysts (BOCs), and are thought of to function by several distinct mechanisms.

After lipids have been broken down into glycerol and fatty acids, microbial degradation of these two lipid components can take place even though they have markedly different characteristics. Once glycerol is released from a lipid, it becomes very miscible in water and will not be detected by the analytical methods used for the quantitative analysis of fats, oils and greases (FOG, TOG). Due to its high solubility in water, glycerol is rapidly metabolized by wastewater microorganisms.

The primary mechanism for the breakdown of fatty acids is the “Beta Oxidation Sequence” (beta oxidation) or the Leloir Reaction. In beta oxidation, the beta methylene group (second from the end) is oxidized to a ketone group, followed by the removal of the two carbon fragments from the fatty acid chain. The most common group of lipids encountered in nature are neutral fats (acylglycerols), which serve as the major components of energy storage in plants and animals, especially in vertebrate animals as an adipose (fat) tissue. A neutral fat or lipid molecule consists of a glycerol ($\text{CH}_2\text{OHCH}_2\text{OHCH}_2\text{OH}$) molecule to which fatty acid (RCOOH) chains have been attached by esterification to form fatty esters (RCOOR'). Concentrations of FOG contributed by the remaining fatty acids will be reduced, as the fatty acids are metabolized by microorganisms.

The enzyme system involved in the splitting of these two carbon fragments is Coenzyme A (CoA). The removal of the two carbon units is achieved by the formation for acetyl-CoA and an acid-CoA complex. The acetyl-CoA enters into microbial metabolism through the Krebs Tricarboxylic Acid Cycle, which eventually releases the CoA for additional reactions.

BOC will stimulate beta oxidation:

- Beta oxidation is an aerobic process and BOCs have been shown to increase the mass transfer of oxygen into fluids;
- BOCs contain some of the biochemical precursors required by microorganisms to synthesize factors used in beta oxidation; and
- BOCs contain small, but detectable, concentrations of CoA

The catalytic breakdown of crude oil, jet fuel, diesel, fats, oils, and greases (FOG) components, the lipids, and other non-solubilised organic wastes within the waste stream and other organic contaminants; eventually biodegrading them to carbon dioxide and water as the end products, allowing for the following benefits;

- Accelerated biological reduction of FOG and Hydrocarbons
- Increased flows and contaminant levels to be processed by a wetland system.
- Effluent discharge quality is greatly improved in existing wetland systems.
- Wetland systems experiencing clogging will be cleaned out, optimum performance is restored.
- Engineered wetland systems with BOC can operate efficiently using a reduced land space.

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Clogging:

With time gravel beds will become clogged with accumulated solids and bacterial film. The material is often replaced every 8 to 15 years or more. Maintenance activities should focus on ensuring that primary treatment effectively lowers organics and solids concentrations before entering the wetland. Testing may be required to determine the suitability of locally available plants with the specific wastewater. The vertical system can require more maintenance and technical expertise than other wetland technologies.

For a safe operation with high nitrification rates and reduced soil and gravel clogging it is essential to preserve aerobic conditions in the filter. The challenge is to keep aerobic conditions in the filter during system operations. This can be achieved by dosing BOC into the influent stream, generally 1 PPM for every 100 BOD of influent. This will increase oxygen transfer efficiency and greater dispersion of oxygen continually throughout the water column. Bio-fouling (bio-film) and clogging due to solids accumulation is also controlled thus eliminating system failure from clogging.

With forced bed aeration systems BOC is diluted and injected into the air flow with a dosing pump using atomizing nozzles 20 to 25 microns, this will facilitate the creation of BOC micro-bubbles upon exit in the medium that will control clogging, increase oxygen transfer and start the "BOC effect " Total System Enhancement, (TSE).

BOC is unique in the ability to provide substantial improvements in dissolved oxygen levels, while simultaneously reducing the energy requirements of aeration systems. This is both economically compelling, as well as critically important when the wastewater system is attempting to treat heavier organic loadings than it was optimally designed for. Aeration system energy consumption can be reduced by 20% to 35% with BOC, offering considerable savings and reduced environmental footprint.

Clogging is one issue that has limited widespread application of engineered wetland systems. Clogging is a complicated process with physical (such as physical filtration), biogeochemical and plant-related processes. Experience has demonstrated that suspended solids accumulation and bio-film have contributed to this problem. BOC greatly enhances the biological reduction of suspended solids and is widely used in wastewater treatment systems around the world providing bio-film, odor and FOG control, increased oxygen transfer and a significant reduction of total suspended solids (TSS), total nitrogen, chemical oxygen demand (COD), reduction of mineralization build-up, ammonia reduction and phosphate reduction.

Short term high dosing of BOC will result in a rapid clean out effect of the entire system. This is useful in older systems to extend its operational life and avoid the physical removal of the clogged medium.

Continuous low dose injection of BOC will result in increased operational efficiency, reduced maintenance and possibly extending the life span of the system indefinitely.

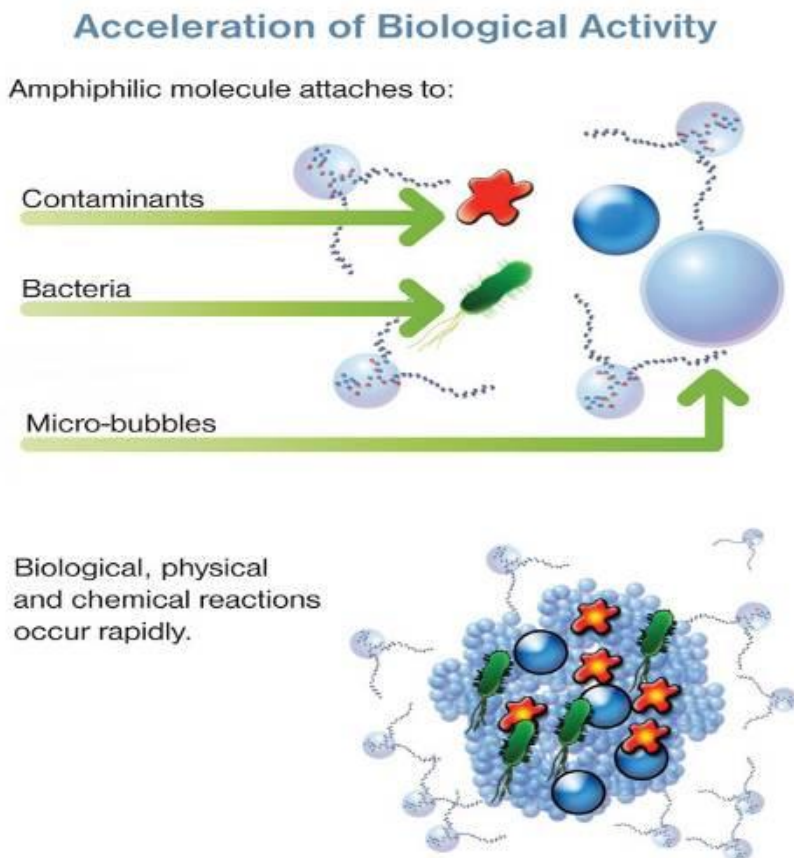
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How it Works:

BOCs process works synergistically to enhance the processes of oxygenation/ gasification through micro bubble formation, rapid solubilisation of greases and bio-films and enhanced ionic amphiphilic interactions to make nutrients more available to indigenous facultative bacteria. The oxygen uptake rate (OUR) is significantly increased as favourable conditions are created to enhance the respiratory activity of microorganisms. The favourable conditions are created by:

BOCC's proprietary product being introduced into the incoming flow or forced air system, on contact with water BOC micro-bubbles are formed increasing oxygen transfer that supports BOCs amphiphilic molecules that attach to components such as - bacteria, oxygen, and other decaying organic matter in the wetland.

These components then self-organize into a loose aggregate, creating an ideal situation for biological, physical and chemical reactions to rapidly occur by enhancing the speed of biological COD degradation and respiratory activities of the micro-organisms. Both ionic and amorphic interactions being enhanced, accelerating the chemical oxidization of inorganic pollutants.



The BOC products are all based upon a breakthrough technological understanding of how to unlock the inherent transformation power of natural biological pathways. The rate of gas (oxygen) transfer is critical to all aerobic biological processes. Breaking molecular bonds and releasing pollutants into more digestible form for microorganisms to consume as a food source.

The BOC product line is built upon the powerful bio-catalytic capabilities of a fermentation supernatant, derived from plants and minerals, which is then blended into a very powerful bio-catalytic liquid concentrate which when diluted into water creates highly self-organized and ultra-fine micro-bubbles that allow an acceleration of biological and chemical reactions within organic wastes and sewage.

These ultra-fine micro-bubbles have very high gas (oxygen) transfer characteristics. More available oxygen enables a speeding up the natural biological degradation processes and faster aerobic reactions.

Improved gas transfer rates adds improved conversion of insoluble organic waste components, along with enhanced maximum utilization of molecular oxygen, makes this revolutionary bio-catalytic chemistry vastly important to a broad array of environmental and waste conversion objectives.

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Sludge reduction:

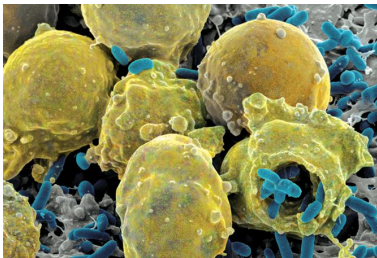
BOC will facilitate a higher conversion of organic wastes; reduce energy usage, and lowering sludge volumes. BOC will therefore substantially expand a wetlands total loading and capacity ability with increased conversion of organic waste (sludge). By greatly lowering the quantity of TSS, and bio-solids accumulation thus increasing a natural cleaning action and avoid system clogging.

BOC is unique in the ability to provide substantial improvements in dissolved oxygen levels, providing reduced energy requirements of the aeration system. This is both economically compelling, as well as critically important when the wastewater system is attempting to treat heavy organic loadings than the system is optimally designed.

The capability to not only eliminate H₂S gas levels and odors, grease clogging is unequaled by any other technology on the market. Ultimately, BOC offers a tool to create within the wetland system an accelerated aerobic biological breakdown of the organic loading (BOD/TKN) of the sewage prior to entering the wetland when BOC is injected into the incoming pipe prior to entering the wetland. This type of BOC injection prior to entering the wetland would also reduce biomass concentration at the inlet, further reducing sludge accumulation and clogging.

Bio-Film:

Biofilms (spatially and metabolically structured microbial communities) play an important role in wetland pollution treatment; they are responsible for the majority of waste contaminant biodegradation while other fungi algae and plants are also important. Biofilms form on most surfaces within a wetland very quickly and continue to grow as it is a perfect environment being water with plenty of nutrients available. Biofilm (microorganisms) consume organic material and ultimately release carbon dioxide and water, or methane and water, depending on the amount of oxygen present.



Biofilms also contribute to clogging, both the growth and detachment of biofilm were discovered to add to the clogging process under commonly used hydraulic loading in vertical constructed wetlands. In addition, the existence of the biofilm enabled the suspended solids to combine much easier, which accelerated the settlement and interception of the solids. The biofilm secreted extracellular polysaccharides, which added to the adhesion property of the substrate. Thus, more solids were captured, and the occurrence of clogging was accelerated. Finally, the conceivable clogging process mainly caused by biofilm eventually becomes an issue.

The success of constructed wetlands in treating process wastewaters containing high-strength organic matter depends on several factors related primarily to organic loading, HRTs, the tolerance of selected plants to possibly toxic components in the process wastewater, and being able to maintain a healthy biofilm (bacterial community).

Because filtration and growth of biomass leads to an accumulation of matter in the filtering media that results in clogging the media may have to be physically removed. This can be successfully prevented with the introduction of BOC. BOC has the proven ability to degrade the extracellular polysaccharide (biofilm) produced by the bacteria. The level of biofilm growth throughout the wetland can be regulated with the use of BOC to prevent clogging.

BOCs proven effectiveness at degrading biofilms can be used to clean out and restore clogged wetlands with higher dosing, restoring the biological functions of the wetland to a healthy unclogged status. With constant low dosing of BOC the wetlands biological integrity will be maintained fresh and healthy, Experience has demonstrated that low dosing of BOC promotes and maintains healthy bacterial communities and prevents clogging of the filter media.

Engineered Wetland Environmental Enhancement

The introduction of BOC to wetlands or forced bed aerated systems provides the ability to treat higher flow rates of pollutants within established systems and increase market share by providing systems in areas previously unavailable due to land requirements or high strength influents.

We predict with the use of BOC the land required to fully process effluent will be reduced up to 50%, making engineered wetlands for pollution treatment available to cities, communities and industries with limited available land.

Depending on the method of delivery and system design BOC can effectively create these reactions at 1ppm, making Bio-Organic Catalyst a viable solution to increasing pollution loads and a method to overcome many of the limitations of engineered wetland pollution treatment systems.

Fast Results:

BOC offers dramatic improvements achieved very quickly in waste water treatment facilities or engineered wetlands, resulting in superior odor control, Rapid FOG elimination, and aeration energy savings. System efficiency is optimized and results are seen within a few days.

Shifting the Nature of Biological Treatment:

The biological mechanisms of the treatment system are beneficially and fundamentally changed, thus reducing major organic contaminant loads from the waste stream. This results in dramatic improvements in reduction of collection system corrosion of concrete, steel, and aluminum surfaces from H₂S gases, loading and throughput at the plant, and reduced energy costs, sludge disposal costs, maintenance and downtime.

Displacing Capital Expenditures:

BOC can immediately increase the efficacy and efficiency of wastewater treatment systems, enabling capacity expansion to be deferred for years. The avoidance of capital costs, coupled with lowered operating costs, has the potential to significantly restructure water treatment project economics in favor of BOC biocatalysts.

Cold Climates:

The use of BOC during the cold season will enhance the biological integrity of the wetland and provide the many benefits already discussed thus the efficiency of the wetland to process pollutants are restored to or beyond warm weather capacity.

Increased Carrying Capacity:

BOC enhances all biological functions and accelerates the remediation of pollutants in less time and space normally required therefore carrying capacity can be increased.

Biological Health:

The introduction of BOC to an engineered wetland provides all the essential requirements for biological growth and vitality by offering increased available oxygen, pollutants degraded into a biological consumable form. Upon entry to the wetland toxic elements like hydrocarbons are eliminated thus the biological integrity remains intact even under heavy loading or toxic contaminants, system overload is much more difficult to achieve.

Engineered Wetland Environmental Enhancement

Nitrification:

The potential of using BOC to improve nitrification processes is promising due to the oxygen demand required for oxidation of ammonia to nitrate. Ammonia oxidizing bacteria (Nitrosomonas) obtain their energy by oxidizing ammonia nitrogen to nitrite nitrogen and the nitrite oxidizing bacteria (Nitrobacter) by oxidizing nitrite to nitrate nitrogen. The oxygen demand for complete nitrification is high as nitrifiers are aerobic and adequate dissolved oxygen levels must be maintained to sustain nitrification. BOC has been shown to increase dissolved oxygen levels and lowering the transition of energy required for a catalytic reaction to occur. The Company has also conducted test programs on the addition of a BOC prior to sludge dewatering for ammonia reduction. These studies showed : Reduction of Ammonia concentrations: In the filtrate was reduced 45% to 66% from its untreated level after a contact time with the BOC of between 2 and 3 minutes. Ammonia odor reduction: The filter press operator stated that during the trial, the odor from the filter press was significantly reduced (75%).

Pesticides:

Wetlands can struggle with high concentrations of industrial wastewater that includes pesticides, herbicides or large amounts of ammonia. With BOC injected in to the influent, bioremediation of these compounds is accelerated by up to 100 times, allowing for high strength influent to be successfully processed in less time and space.

In conclusion:

BOC naturally energize and accelerates bio-remediation rates of Total Petroleum Hydrocarbons within the wetland system on contact as well as enhancing the biological consumption of other pollutants, this together with superior oxygen transfer and enhanced biological integrity provides improved conditions for all ecological functions within the wetland system providing many benefits and opportunities for the industry. There is no other technology available that is as effective as BOC and environmentally beneficial that can be implemented to deal with high pollution levels in an engineered natural waste treatment system that offers environmental enhancement and pollution reduction simultaneously.

