EXCEL® INTERNATIONAL, INC.
VIRGINIA - USA

EXCELAGEST™
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# What role does ExcelAGEST have in Waste Water Treatment?

## MICROORGANISMS ROLE IN AEROBIC WASTEWATER TREATMENT

Among wastewater types we find: domestic (houses), municipal (state or city), industrial (industries). There is one characteristic they all share (organic matter breakdown by bacterial digestion). These microorganisms are broadly distributed; we can find them in mankind systems as Wastewater Treatment Plants and natural systems as soils, rivers, lagoons and the sea.

Human have developed knowledge and technology for wastewater treatment that has led us to use microorganisms for our benefit, this technology is as old as Pasteur experiments to bring Pasteurization, then we had lactic fermentation and thus all these technology now is known as Biotechnology.

Any kind of wastewater exhibits a variety of microorganisms, as we said before, microorganisms can be classified as: aerobic microorganisms (require oxygen), anaerobic (does not require oxygen) and facultative (survive with or without oxygen). Each group has specific functions or abilities for a specific system substrata or food as well as tolerance to ecological maximums and minimums such as: pH, temperature, oxygen levels and nutrients.

Bio augmentation Is a term that describes a biological waste treatment in water and soils. This means that by adding specialized microorganisms we promote organic matter remotion and/or the capacity of biodegradable component to degrade; all to increase biomass but not for replacing biomass.

Cultures are produced by Biotechnology, each product adapts itself to the Bio system for specific uses, its composition is based on a synergistic microorganism fusion that secures consistent and predictable results for a wide variety of environmental applications.

Among the most frequent problems in WWTP where Bio augmentation is recommended we have:

- BOD-QOD overloading
- Poor clarification
- Carbon variations
- Grease and oils
- Odor
- Foam
- Toxics

An ecologically friendly way of BOD decrease ( Excelagest PRODUCTS: WA , WA3, y WA33), specifically designed with adequate combination of microorganisms is now available, something that with time will replace chemicals use and environment abuse. Our Biotechnological products contain different microorganism species that have affinity for organic substances as: xenobiotic, phenols, nitrates, phosphates and proteic compounds.

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## How the process takes place?

This process is a biotechnological method for wastewater treatment that is done with a microorganism mix in an aerobic environment. These microorganisms derive energy from organic matter in the aerated treatment systems for the production of new cells in a process know as respiration. This microorganism consortia is the basic component of the process.

The global goal of Excelagest is to remove substances that demand oxygen from the system. This is achieved by metabolic synthesis reactions, nitrification, de-nitrification process and solid separation for the creation of an acceptable effluent quality and recycling of microorganisms back to the system (sludge reduction).

The dominant microbial species in a system such a WWTP depends upon the environmental conditions, design process, and the wastewater plant operation and influent characteristics.

## MORE VITAL CHARACTERISTICS OF MICROORGANISMS

### What happens if the pH level is not adequate for microorganisms?

Three points define the range in pH over which microorganism grow: minimum pH (value for which organisms can not growth), optimum pH (value for which the organism has an optimum growth) and maximum pH (value up to which an organism can not grow). Organisms that grow at optimum pH (7.0) are neutrophils, those that grow at an acid pH (lower than 7.0) are called acidophilus and the ones in the middle are called alkalophiles.

### What happens if the temperature is not adequate?

Temperature is a determining factor for the survival of an organism. The metabolic type and tolerance that will characterize a microorganism depends on the temperature at which they grow. Among these are: psychrophilic, mesophylls, moderate thermophiles, mesophylls, extremes and archaeas (extreme environments).

### What happen if there is not enough oxygen?

The organism's response to oxygen depends on the occurrence and distribution of various enzymes reaction with oxygen as well as various oxygen radicals that are invariably generated by the cell in the presence of oxygen. All cells contain enzymes capable of reacting with oxygen. For example, flavoproteins; pro-oxygen oxidations invariably result in the formation of peroxide ($H_2O_2$) as one of the major products.

Even many of the bacteria, as the lactic acid one, lack catalase and de-compose $H_2O_2$ by peroxidases, which derive $NADH_2$ electrons for the reduction of peroxide to $H_2O$. Anaerobic organisms that lack

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dismutase, catalase or peroxidase, undergo lethal oxidations when exposed to various oxygen radicals. In other words, there is a linear relationship between metabolic type of microorganisms and dissolved oxygen in the system, this oxygen level is what most be care of.

## Why is it important that our WWTP has an aeration system?

We can analyze this question by making an analogy between a WWTP and a lake. Both are water bodies; the difference is that one is in contact with other systems (natural environment), while the WWTP is an isolated system. Another comparison we can make is by visualizing the characteristics of a WWTP without natural movement and no aeration (no dissolved oxygen), which passes through the same process as in a lake with no oxygen available, resulting in STAGNATION.

The Excelagest system provides adequate system of aeration by pumping air into it. These pumps are programmed for working in alternate processes as in a lake with, which we provide aerobic and anaerobic microorganisms that have the oxygen they require in adequate proportions.

## What happens with the dissolved oxygen and great amount of organic matter?

Although oxygen is one of the most common atmospheric gases (after nitrogen), it has limited solubility in water. In lakes (as well as in WWTP) when oxygen has been consumed, superficial layers become anoxic (without oxygen). Strict aerobic microorganisms can not grow in the bottom layers restricted to anaerobic bacteria. Additionally, there is a conversion from respiratory metabolism (which is the normal and the desired one) to fermentative (bad odor increment, decomposition, non-desired one), thus, bringing important consequences for the carbon cycle and other nutrient cycles in lakes; and in case of WWTP sludge accumulation, bad odors decomposition.

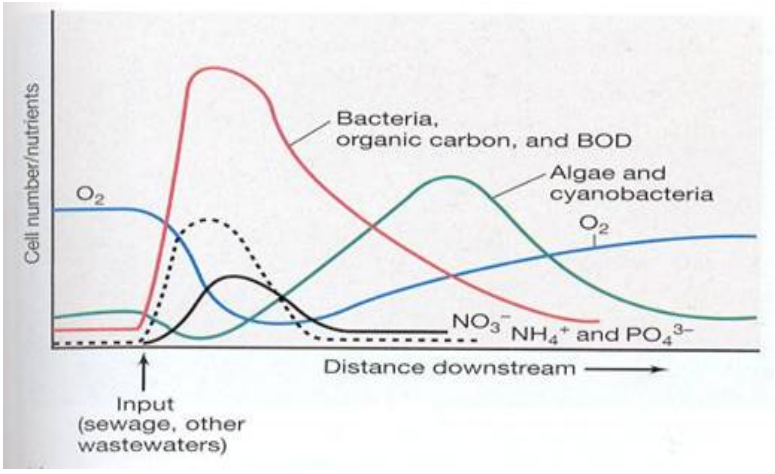


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*Figure 1. The relation between BOD, oxygen, nitrate, ammonia and phosphate after significant organic matter load in a river.*

In an open water body, oxygen is present in its dissolved form, we don´t need for oxygen supply but if organic matter is introduced sporadic -as it is in non productive lakes with organic matter excess) or WWTP with high BOD levels; dissolved oxygen drops and BOD or organic carbon increase reflecting in significant organic matter load that needs to be dissolved.

After any organic matter load, an increment in BOD levels is observed and consequent decrease in dissolved oxygen, not counting following algae growth.

The rate at which water motion occurs in correspondence with surface water is very important, in terms of WWTP's we talk about how is the system aeration going. When this water masses movement occurs along with turbulence currents (lakes), water mass must be well mixed and consequently the oxygen will be transferred to the deepest layers; in other words, good aeration and enough organisms of the ones that consumes organic matter excess) gives efficient performance of a lake or a WWTP.

In many template lakes, water masses stratify (separate) during spring. Surface warm layers are less denser (up-side) and get separated from cold waters, which are dense (bottom-side). This is what is called stratification and as a result bottom water becomes anoxic. At the end of autumn and the beginning of winter, surface water becomes colder and denser than bottom water – then we have consequent water mass movement-. Most lakes in template climates have this annual cycle in which bottom waters passes from oxygenic to anoxygenic and then back again.

Microbiological activity changes with oxygen level fluctuation. All of these information is for understanding a way to compare our WWTP and a natural lakes in terms of their function. In Excelagest, we enhance Nature's job by adding benefic microorganisms ( Excelagest WA ) so they can consume stagnate organic matter.

## THE RELATIONSHIP BETWEEN ORGANIC MATTER AND OUR BACTERIAL PRODUCTS

### Why do I have to keep on adding bacteria after the start-up?

Again, we will make an analogy of our WWTP and natural water system like a river. Rivers have certain particularities that will help us to understand how the microenvironment in our WWTP works.

Oxygen relationship in rivers is of a particular interest. Especially in regions where rivers get a lot of organic matter in the form of wastewater and industrial contamination, even when a river is well mixed (because of the rapid flux and turbulence), there are great quantities of aggregated organic matter that can lead to oxygen deficit in microbial respiration. In WWTP, the equivalent would be great wastewater discharge, lack of aeration and few beneficial bacteria.

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When water moves outside the wastewater effluent, organic matter is gradually consumed and organic oxygen content rebounds to normal. Lack of oxygen in any water body is not desirable. This causes lots of aquatic animals to die. In WWTP the "dead ones" die because of high organic matter and variable oxygen conditions, such as our beneficial organisms. Nature takes care of this tuff tough work by natural processes but our help necessary.

## How does our system works?

We elevate microorganism quantities of the ones that are capable of organic matter degradation in a process known as Bioaugmentation.

## What is BOD (Biochemical Oxygen Demand)?

Sanitation Engineers have named biochemical oxygen demand as BOD). Normally, putting a water sample in a bottle and pumping air into it determine BOD. The way it is done is by placing the sample in a bottle for a standard time (usually 5 days) and after this time the final oxygen leftover is determined. The standard test lasts 5 days, after which oxygen excess is determined after the incubation period.

The BOD test gives us a measure of the organic matter quantity that can be oxidized by microorganisms.

## BOD/COD levels

A common problem is the ability for controlling BOD/COD levels in WWTP, due to lack of oxygen in the system, based on mechanic process that generates air and oxygen in relation with system volume capacity which might not been working properly or is not the adequate one.

Traditional methods tend to increase oxygen levels (dissolved oxygen) and/or to increase retention capacity.

This is the typical engineering solution and most of the times it doesn't resolve the problem.

In aerobic conditions, failing systems are commonly associated to incorrect carbon, nitrogen and phosphorous levels. Liebig Law states that "Productivity of any complex system depends upon numerous essential supplies and is limited by a single variable".

In this case, at the time of been oxidizing, bacteria produce acids, thus, disrupting microorganism's population balance. Because of the competitive nature of microbes, not benefic bacteria will dominate, producing an excessive level of toxins and thus dominating pathogens and toxins. This is reflected in system disruption and high BOD levels and bad fetid odors.

Native microbes (typically found in water treatment systems) are commonly attacked by system components: solvents, disinfectants and chlorination, all of these causes detriment in microbial populations and make bacterial population less efficient.

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This is how tanks deposits get stagnant, biomass accumulation takes place and lines swing; just to mention some of the problems we face when bacterial population is not maintained at optimum levels.

With a better understand of inhibitory factors for microbial populations to decrease, we identify the cause of the problem and thus repopulate the system with specific microbes in a process called Bio-augmentation.

In Excelagest we have evaluated the biological parts of the system in WWTP through studies done under an ecological, practical and economical point of view and continuous improvement and identification of key problems regarding

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