NatureClean Bacterial / Aeration System Information:

The bacterial formulations have been devised and tested over the past 15 years to work synergistically to break down the unique bio-degradable found in dairy / human / industrial waste. The indigent bacterium that is already found in the waste is not capable of efficiently and quickly degrading the solids and chemicals (nitrates, nitrites, salts, phosphorus etc) found in such abundance in manure. The NatureClean formulations with many specialized strains of naturally occurring microbes in very high quantities, with each species selected for a specific purpose breaks down and eliminates the problems. The select microbes are designed for cellulose digestion, ammonia reduction, nitrate, nitrite, phosphorus, site specific pharmaceuticals and overall water cleanup. Salt reduction is by cellular conversion and absorption in cellular biomass.

In this aerobic system, the high Oxygen generation and saturation of the systems, combined with specialized formulations of bacteria, is effective against the following harmful anaerobic bacteria:

– Salmonella
– Cholera
– E. Coli
– Streptococcus
– Pseudomonas
– Staphylococcus
– Various parasites and microorganisms including Giardia lamblia

After putting dairy waste through this type of system we have found the TDS (total dissolved solids) is lower in salts than some waters used for irrigation in Southern California. There is shown in the decrease in EC (Electrical Conductivity – a measure of the soluble salts) that translates to a decrease of from 3 to 5 tons less salt per acre-foot in the product water. The product water has been utilized to irrigate silage crops. The results are showing higher yields and the tissue analysis as high as a 40% increase in protein and a 30% increase in tonnage as compared to when straight well water was used.

NatureClean has spend 3 years developing a dairy waste / animal waste system to solve the growing problems in the dairy, cattle, pig and other CAFO operations. We have been able to reduce or eliminate scours (E. Coli) and can eliminate the pharmaceuticals used in the industries. By using the effluent to irrigate and penetrate the contaminated areas around the farms, we can decontaminate years of built up toxics. This, in many cases, can save the family farms and reduce the contamination of large dairies.

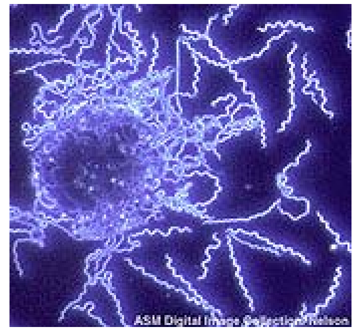
NatureClean Aeration Systems inject compressed air to a water body using non-clogging, maintenance free diffusers. When compressed air is released at the bottom of a pond / or tank it will naturally begin to migrate towards the surface of the water. As it travels up the water column the pressure surrounding the bubbles slowly decreases causing the bubbles to increase in size. Due to the fact that larger bubbles displace more water than smaller bubbles a slight current begins to develop. This current draws oxygen-depleted water from the bottom, oxygenates it and transports it to the surface. This action breaks down stratified waters while increasing dissolved oxygen levels and protecting fish, aquatic organisms and beneficial bacteria from suffocation.

Membrane Diffusers are not new; they are a proven aeration device that works. How do they work? The oxygen transfer from any aeration device comes from the surface of the bubbles, the same as the surface of a pond. With the systems surface the transfer is slower because of there being only one large surface integrating with the air. With aeration devices you have more surfaces. With big bubbles you have less surface area. With smaller bubbles, millions of bubbles, you have millions of reactive surfaces to transfer oxygen.

The vibration of the membrane surfaces is what keeps them clean. When used in large sewer pump stations this vibration keeps the membranes free from grease buildup by not allowing the grease to settle. The same happens here, the solids will not settle and stick because of the air rising and the vibration of the surface. That is one main reason that there is so very little maintenance of these devices.

This system is the most advanced and proven system for wastewater that is available today. It is the system that will treat the waste to the standards that will be required for decades to come. All other systems are “old technologies” and treat only parts of the problem. The NatureClean System is the only one that treats “the whole problem” with the newest innovations and technologies.

Bacteria

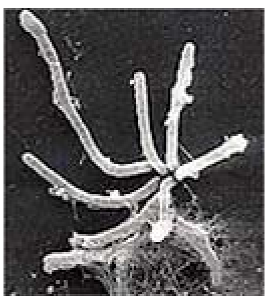


Borrelia burgdorferi
Nelson, ASM MicrobeLibrary

Bacteria consist of only a single cell, but don't let their small size and seeming simplicity fool you. They're an amazingly complex and fascinating group of creatures. Bacteria have been found that can live in temperatures above the boiling point and in cold that would freeze your blood. They "eat" everything from sugar and starch to sunlight, sulfur and iron.

There's even a species of bacteria—*Deinococcus radiodurans*—that can withstand blasts of radiation 1,000 times greater than would kill a human being.

Classification



Leucothrix mucor
Appl. Environ. Microbiol. 55:1435-1446, 1989

Bacteria fall into a category of life called the Prokaryotes *(pro-carry-oats)*. Prokaryotes' genetic material, or DNA, is not enclosed in a cellular compartment called the nucleus.

Bacteria and archaea are the only prokaryotes. All other life forms are Eukaryotes *(you-carry-oats)*, creatures whose cells have nuclei.

(Note: viruses are not considered true cells, so they don't fit into either of these categories.)

Early Origins

Bacteria are among the earliest forms of life that appeared on Earth billions of years ago. Scientists think that they helped shape and change the young planet's environment, eventually creating atmospheric oxygen that enabled other, more complex life forms to develop. Many believe that more complex cells developed as once free-living bacteria took up residence in other cells, eventually becoming the organelles in modern complex cells. The mitochondria *(mite-oh-con-dree-uh)* that make energy for your body cells is one example of such an organelle.

What They Look Like


Ball-shaped Streptococci

There are thousands of species of bacteria, but all of them are basically one of three different shapes. Some are rod- or stick-shaped and called bacilli *(buh-sill-eye)*.

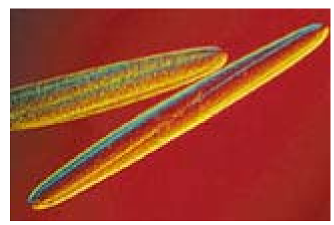
Others are shaped like little balls and called cocci *(cox-eye)*.

Others still are helical or spiral in shape, like the *Borrelia* pictured at the top of this page.

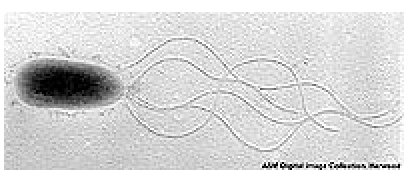
Some bacterial cells exist as individuals while others cluster together to form pairs, chains, squares or other groupings.

Where They're Found

Bacteria live on or in just about every material and environment on Earth from soil to water to air, and from your house to arctic ice to volcanic vents. Each square centimeter of your skin averages about 100,000 bacteria. A single teaspoon of topsoil contains more than a billion (1,000,000,000) bacteria.


Bacteria that live in guts of surgeon fish
Courtesy Norm Pace

How They Move

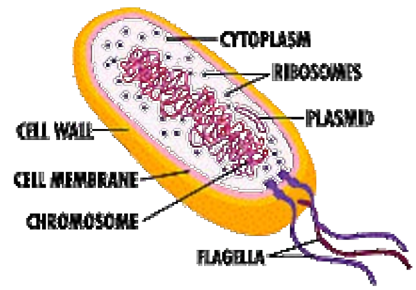


Bacterium with flagella
Harwood, ASM MicrobeLibrary

Some bacteria move about their environment by means of long, whip-like structures called flagella. They rotate their flagella like tiny outboard motors to propel themselves through liquid environments. They may also reverse the direction in which their flagella rotate so that they tumble about in one place. Other bacteria secrete a slime layer and ooze over surfaces like slugs. Others are fairly stationary.

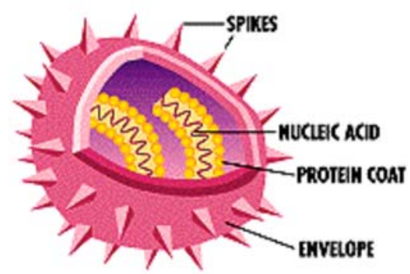
Because bacteria and viruses cause many of the diseases we're familiar with, people often confuse these two microbes. But viruses are as different from bacteria as goldfish are from giraffes. For one thing, they differ greatly in size. The biggest viruses are only as large as the tiniest bacteria. Another difference is their structure. Bacteria are complex compared to viruses.

A typical bacterium has a rigid cell wall and a thin, rubbery cell membrane surrounding the fluid, or cytoplasm (*sigh-toe-plasm*), inside the cell. A bacterium contains all of the genetic information needed to make copies of itself—its DNA—in a structure called a chromosome (*crow-moe-soam*). In addition, it may have extra loose bits of DNA called plasmids floating in the cytoplasm. Bacteria also have ribosomes (*rye-bo-soams*), tools necessary for copying DNA so bacteria can reproduce. Some have threadlike structures called flagella that they use to move.



© Eric MacDicken

A virus may or may not have an outermost spiky layer called the envelope. All viruses have a protein coat and a core of genetic material, either DNA or RNA. And that's it. Period.



Which brings us to the main difference between viruses and bacteria—the way they reproduce.

Viral vs. Bacterial Reproduction

Bacteria contain the genetic blueprint (DNA) and all the tools (ribosomes, proteins, etc.) they need to reproduce themselves. Viruses are moochers. They contain only a limited genetic blueprint and they don't have the necessary building tools. They have to invade other cells and hijack their cellular machinery to reproduce. Viruses invade by attaching to a cell and injecting their genes or by being swallowed up by the cell.

What They Eat

Some bacteria are photosynthetic *(foe-toe-sin-theh-tick)*—they can make their own food from sunlight, just like plants. Also like plants, they give off oxygen. Other bacteria absorb food from the material they live on or in. Some of these bacteria can live off unusual "foods" such as iron or sulfur. The microbes that live in your gut absorb nutrients from the digested food you've eaten.

Bacteria have a wide range of environmental and nutritive requirements.

Most bacteria may be placed into one of three groups based on their response to gaseous oxygen. **Aerobic** bacteria thrive in the presence of oxygen and require it for their continued growth and existence. Other bacteria are **anaerobic**, and cannot tolerate gaseous oxygen, such as those bacteria that live in deep underwater sediments or those which cause bacterial food poisoning. The third group is the **facultative anaerobes**, which prefer growing in the presence of oxygen, but can continue to grow without it.

Bacteria may also be classified both by the mode by which they obtain their energy. Classified by the source of their energy, bacteria fall into two categories: heterotrophs and autotrophs. **Heterotrophs** derive energy from breaking down complex organic compounds that they must take in from the environment -- this includes saprobic bacteria found in decaying material, as well as those that rely on **fermentation** or **respiration**.

The other group, the **autotrophs**, fixes carbon dioxide to make their own food source; this may be fueled by light energy (**photoautotrophic**), or by oxidation of nitrogen, sulfur, or other elements (**chemoautotrophic**). While chemoautotrophs are uncommon, photoautotrophs are common and quite diverse. They include the cyanobacteria, green sulfur bacteria, purple sulfur bacteria, and purple nonsulfur bacteria. The sulfur bacteria are particularly interesting, since they use hydrogen sulfide as hydrogen donor, instead of water like most other photosynthetic organisms

NatureClean-33

Bacteria cultures are the only method that can eliminate the waste problem. They are living organisms that continually adapt and grow in the system. They consume the waste, chemicals, medicals; they do not move it from one place to another.

Many strains of bacteria will not eat grease, fats, oil, protein, phosphates, nitrates, sulfates or other different chemicals under any circumstances. They simply die off. The only effective formula is one that will biodegrade the entire different biodegradable that are uniquely found in the human / dairy / industrial waste. This requires a carefully selected formula. NatureClean includes bacteria strains that will degrade the entire different biodegradable found in the waste. The cultures were first developed in the laboratory and tested to find the best bacteria for breaking down waste. Then we tested them in dairy / human / industrial facilities to find the right formulations. This formulation was developed over 20 years of careful experimentation and development.

Carefully selected means exactly that. Not every bacterium will consume each of the different substrates found in waste. As a matter of fact, there is no such thing as bacteria that prefer to eat all waste. Most bacteria would rather eat carbohydrates (sugars, starches, and cellulose) first. Next they will choose protein. After all that is gone, they will work on the fats and greases starting with the ones that are easiest to break down. Then there is the need for specialized bacteria to rid us of odors (H2S) and phosphate, nitrates, nitrites and sulfates. For instance, almost any grease enzyme combination or simple bacteria product will work to some extent in a restaurant line because the waste stream usually consists of a predictable, high quality grease. However, a municipal sewer carries everything known to man. At any given moment, you will find many varieties of chemicals, soap, petroleum products, cellulose, and numerous other compounds. However dairy waste is somewhat constant in that the foods cows eat are standard without too much variance. Therefore we have developed a very potent specialized combination of bacteria especially for C.A.F.O. (Confined Animal Feeding Operations) operations.

In addition, the pH of the water can swing back and forth without notice. On top of this, the stream can change characteristics without warning when someone dumps something down the line. We have bacteria that are capable of efficiently working in a pH variance of 2 to 10

If you want to clean a waste water system, you better use the big guns. Half measures and bad products simply will not get it done. To the best of our knowledge, **NatureClean-33** contains more strains of specific bacteria than any other formula available, **58** strains. It is necessary to have this formula because of the complexity of dairy / human / industrial waste systems. Also note that our plate count is extremely high—the highest count we've ever seen.

While plate counts are important, they are not what determine the best product. Always remember that we are not playing a quantity game; we are playing a QUALITY game. If you could clean dairy ponds solely with a vast number of bacteria, no dairy would need you. If you take a plate count of almost any dairy pond, wastewater plant or septic system, you will find it loaded with bacteria. The plate count may even be higher than our formula. There plenty of bacteria in wastewater, you do not need more bacteria, you needs a whole new cast of characters, one that will handle the complexities of a wastewater.

In order to succeed you must put the right cast of characters on the scene at the right time. If a football coach wants to win a game, it's better if he picks the team instead of taking the first eleven people who show up on game day. Just as the coach needs people with different skills to man his team, we need many strains of bacteria to win the war with waste effluent. On a football field, it's called teamwork. In our systems, it's called synergism.

Synergism is simply a group of bacteria working together to get the job done. For instance, a molecule of grease may consist of several compounds. One strain of bacteria cannot break it down. However, when the right team of bacteria goes to work, each consuming a different substrate (food), the compound is quickly consumed.

Bacteria are the main ingredients in the NatureClean Process. All the rest, air pumps, the membrane diffusers, (the oxygen generators, the ozone generator if very specific circumstances dictate their use), water pumps, bio filters, automated BOD and coliform testers, automated bacterial generation units and automated chlorinators are the supporting cast. They help to establish the living conditions for the rapid and efficient bio-degradation of all the contaminants in the wastewater. Used as directed, the NatureClean Systems will meet all NSF/ANSI Standard 40, Air Quality and EPA Standards to keep or obtain permits. **Most important, is the fact that NatureClean uses only naturally occurring bacteria. We do not use genetically engineered or altered strains. NatureClean maintains a strict adherence to the natural organic processes of nature.**

Bacteria or Enzymes?

1. What are Bacteria?

Bacteria are single-celled organisms that do not have well-defined organelles such as a nucleus. The cells are typically enclosed in a rigid cell wall and a plasma membrane. Bacteria contain all of the genetic material necessary to reproduce, and they reproduce by simple cellular division. Bacteria show a wide range of nutrient requirements and energy-related metabolism. Some bacteria require only minerals and a carbon source such as sugar for growth, while others require more complex growth media. Bacteria play an extremely important role in recycling nutrients in the environment. Bacteria break down organic matter into simple compounds like carbon dioxide and water, and they cycle important nutrients such as nitrogen, sulfur, and phosphorus. Bacteria can migrate to areas that are rich in specific nutrients that they require for growth. Bacteria can also attach themselves to surfaces and form communities known as biofilms.

2. What are Enzymes?

An enzyme is a protein that acts as a catalyst. The enzyme is responsible for accelerating the rate of a reaction in which various substrates are converted to products through the formation of an enzyme-substrate complex. In general, each type of enzyme catalyzes only one type of reaction and will operate on only one type of substrate. This is often referred to as a "lock and key" mechanism. As a consequence, enzymes are highly specific and are able to discriminate between slightly different substrate molecules. In addition, enzymes exhibit optimal catalytic activity over a narrow range of temperature, ionic strength and pH.

3. Do enzymes break down any molecule or just specific ones and how specific do they get:

(Above). The specificity of an enzyme for it's substrate is generally a function of the enzyme's "active site" or binding site. The structure of the protein determines the range of substrates or "keys" that can fit into the lock. Most enzymes are exquisitely specific. That is, they react only with one specific substrate. Some enzymes, however, have a more flexible active site that can accommodate molecules that are closely related to the target substrate. In this case, there is typically a preferred substrate with which the enzyme reacts at a higher rate than with related compounds.

4. Can Enzymes adapt to different conditions and to different grease, oils and food:

Enzymes are not living things. They have no ability to adapt to changing conditions or substrate sources. Their level of activity is a function of these conditions. If they are not in optimal conditions, their activity decreases or stops.

5. How do bacteria break down any molecule or just specific and how specific do they get:

Bacteria have the capability of producing many different types of enzymes. They are living organisms that respond to their environment. In general, bacteria are capable of producing enzymes that degrade a wide variety of organic materials such as fats, oils, cellulose, xylan, proteins and starches. It is important to note that all of these materials are polymers that must be reacted with more than one type of enzyme in order to be efficiently degraded to their basic building blocks. Nature provides a specific "team" of enzymes to attack each type of polymer. For example, there are three different classes of enzymes (endocellulases, exocellulases, cellobiohydrolases) that are required to degrade a cellulose polymer into basic glucose units. All three types of enzymes are referred to as cellulases, but each class attacks a specific structure or substructure of the polymer. Acting individually, none of the cellulases is capable of efficiently degrading the polymer. Bacteria can produce the complete "team" of enzymes that are necessary to degrade and consume the organic materials present in their environment at any given time. Moreover, bacteria can produce multiple "teams" at the same time.

6. Can bacterium adapt to different conditions and to different grease, oils, proteins, chemicals and food:

Bacteria can adapt to a range of conditions and food supplies. They can change the type of enzymes that they produce if the food source changes. They can protect themselves from changes in environmental conditions by forming colonies, biofilms, or spores. Importantly, bacteria live in "communities" made up of different species. Each species fills a biological niche, and the population of each species grows or declines in response to the environment. For example, a community may contain certain species that efficiently degrade grease or proteins or salts and other species that thrive on cellulose.

7. How long do Enzymes work compared with Bacteria:

All enzymes have a limited half-life (minutes to days, depending on conditions). They are proteins that are biodegradable and are subject to damage by other enzymes (proteases), chemicals, and extremes of pH and temperature. An important difference between enzyme-based products and bacterial products is that the enzymes can't repair themselves or reproduce. Living bacteria, however, produce fresh enzymes on a continuous basis and can bounce back following mild environmental insults.

8. How quickly do high enzyme producing bacteria (Protease, lipase and Amylase are what are commonly used in NatureClean CAFO) produce enzymes? And in what quantities:

Production of enzymes begins as soon as the bacteria begin to grow. The cells must obtain nutrients from their surroundings, so they secrete enzymes to degrade the available food. The quantities of enzymes produced vary depending on the bacterial species and the culture conditions (e.g., nutrients, temperature, and pH) and growth rate. Hydrolytic enzymes such as proteases, amylases, and cellulases, etc. are produced in the range of milligrams per liter to grams per liter.

10. Are these quantities enough to start to compare to straight enzyme products:

Since we don't have any information on the enzyme content of current "straight enzyme" products, it is difficult to answer this question. It is also a function of dosing of the product (i.e., how much, how often). In general, one can assume that the customer could have more control over initial enzyme concentration by adding a prepared enzyme product. However, bacterial cultures can produce competitive amounts of enzyme after a short colonization period. Bacteria can grow very quickly, doubling their populations in as little as 20-40 minutes. In some applications, it is common to "boost" bacterial colonization by adding a small amount of prepared enzyme to begin degrading the available food. This is often done in composting processes to jump-start the bacterial/fungal growth.

11. If you use just Enzymes, how many different enzymes would you need to use to effectively eliminate grease, oils, proteins, salts, chemicals and food in a waste stream:

Again, somewhat difficult to answer. This depends on what you mean by "eliminate". Significant degradation would require, at a minimum, several of each of the hydrolytic enzymes: proteases, cellulases, xylanases, amylases, lipases, pectinases, and esterases. Ideally, you would also need oxidative enzymes to degrade recalcitrant materials. Oxidative enzymes are expensive and impractical to manufacture and they require complex co-factors. This type of enzyme is needed to degrade fatty acids, for example.

12. If grease, oils, proteins, salts, chemicals or other bio-degradables are broken down will they regroup in the pipe or ponds again and reform to clog pipes and ponds:

This depends upon how far the grease and oil are broken down. Fats are mainly composed of molecules called triglycerides. Triglycerides contain 3 long-chain fatty acids linked to a 3-carbon backbone (glycerol). The first step in the degradation of triglycerides is the cleavage of the 3 bonds that link the 3 fatty acids to the glycerol backbone. Lipases and esterases are the enzymes that catalyze this first step. While the reverse reaction is possible, it is energetically unfavorable, and the bonds will not re-form (expect under special circumstances). Generally, lipases will cleave one bond at a time to generate free fatty acids and mono- and di-glycerides. The free fatty acids can combine with calcium ions to form insoluble salts. These salts could cause clogs. However, bacteria, unlike straight enzyme products, have the ability to further degrade and utilize the free fatty acids.

13. What does happen to proteins, fats, oils and cellulose?

They are degraded over time if bacteria or appropriate enzymes are present. The more complex the "food", the more time and enzyme it will take to break it down.

14. Will proteins, fats, oils, cellulose and other bio-degradables break down when you have just a few strains of enzymes:

(See answer #12) The wider the variety of enzymes, the more effective and efficient the degradation. Lipases, for example, vary in the range of fatty acid chain length that they can accept as substrate when attacking triglycerides. Some prefer triglycerides with short-chain fatty acid substituents; others prefer long chain fatty acids. One or two lipases in a product will not be effective for all triglycerides.

15. If you have oils in the water, will it encapsulate the enzymes or bacteria?

Most enzymes and bacteria are hydrophilic, or water loving. They naturally repel oil but can exist at an oil/water interface. Under certain conditions when the oil concentration is much greater than the water concentration, an emulsion can form in which water drops containing enzymes/bacteria are dispersed throughout the oil.

16. Does aerobic or facultative anaerobic bacteria contribute to odors or eliminate them:

Aerobic and facultative anaerobic bacteria do not generate the offensive compounds (e.g., hydrogen sulfide) that cause odors.

17. Some facilities will only use air and indigenous bacterium saying any other added bacteria cause odors, can this happen:

The odors are a function of the air supply. The odors are typically caused by anaerobes. Anaerobic bacteria are always present in indigenous populations, and can thrive in pockets of low oxygen concentration, even under aerobic conditions. High quality bacterial products are free of contamination by anaerobes and will not cause odors. However, if bacterial products are added to a system and the air supply is not increased proportionately to accommodate the increase in biological activity, the whole system will go into oxygen deprivation and the indigenous anaerobes will begin to thrive and generate odors. If bacteria are added, the air supply must be carefully monitored and increased accordingly to prevent odors from the indigenous population.

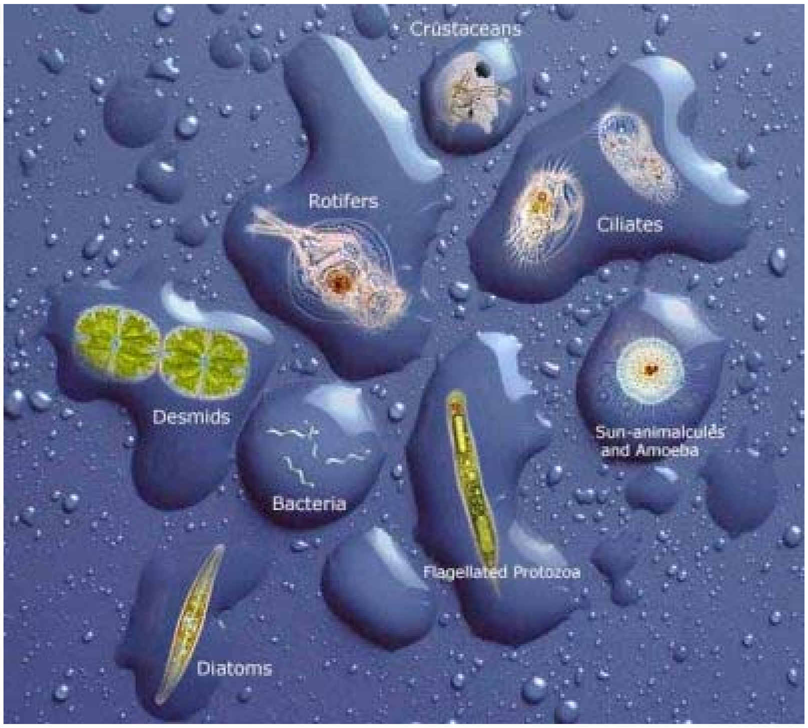
18. Approx how many enzyme types would it take to effectively control waste in a waste stream considering the bio-degradables it contained.

(See question #11)

19. How does this compare with using the NatureClean -33 formula?

NatureClean -33 contains 60 different bacterial strains, each selected for its efficiency at degrading certain waste materials. With the bacterial product, the content of the waste stream determines how many enzymes are produced, in what sequence, at what concentration, and for what duration. The bacteria function as millions of tiny enzyme factories to produce the correct balance of degradative power. This formulation has been derived after a 20 yr long trial and error process. It has been specifically formulated to break down through aerobic and facultative anaerobic action, all the biodegradable substances in the wastewater. It is also formulated with H_2S degrading bacteria and able to work in a pH range of 2.0 to 10.0. It has been formulated for the breakdown of nitrates, nitrites, phosphorus, salts, medicinal and various other chemicals. NatureClean-33 also contains SRO (slow release oxygen) to allow full activity of the bacteria even in low oxygen situations.

Basic Microbiology For Wastewater Treatment



Bacteria are a diverse group of single-celled organisms, most of which are microscopic. Bacteria occur in soil, water, and air, and as symbionts, parasites or pathogens of man and other animals and plants.

Bacteria are either aerobes-growing in the presence of air or oxygen, or are anaerobes-growing without air or oxygen. Some bacteria are "switch-hitters" (facultative anaerobic) who can switch to grow from one environment (air or air-less) to the other.

Besides bacteria, other microorganisms such as fungi (yeasts), protozoa, and micro-animals such as rotifers work in concert to affect water quality.

BOD, COD & DO

Water quality has a number of constituents including biological oxygen demand (BOD), chemical oxygen demand (COD).

Natural organic detritus and organic waste from wastewater treatment plants, failing septic systems, and agricultural and urban runoff, are a food source for water-borne bacteria. Bacteria consume these organic materials using dissolved oxygen, thus reducing the dissolved oxygen (DO) present for fish and other aquatic life. BOD is a measure of the amount of oxygen that bacteria will consume under aerobic conditions.

COD does not differentiate between biologically available and inert organic matter, and it is a measure of the total quantity of oxygen required to chemically break down (oxidize) all organic material into carbon dioxide and water. COD values are always greater than BOD values, but COD measurements can be made in a few hours while BOD measurements take five days.

Pond and Tank Treatment

The main focus our pond / tank. aeration / bacterial system is to reduce the BOD and COD in the effluent discharged to natural waters, meeting state and federal discharge criteria. Our wastewater treatment is designed to function as "microbiology farms," where bacteria and other microorganisms are fed oxygen and organic waste.

Treatment of the organic waste involves biological breakdown of the organics and chemicals contained in the waste. The waste enters a series of 3 ponds or a series of tanks (from one tank to many depending on the quantity of waste) that have embedded membrane air diffusers on the bottom that inject oxygen-enriched air into them. The ponds / tanks are mixed from bottom up to provide laminar lifting and ensures that the entire water column remains aerobic to support rapid microbial breakdown. These treatment steps are generally considered environmental biotechnologies that harness natural self-purification processes contained in the pond / tank bioreactors for the biodegradation of organic matter and bioconversion of soluble nutrients in the wastewater.

Application Specific Microbiology

Each wastewater stream is unique, and so too are the community of microorganisms that process it. This "application-specific microbiology" is the preferred methodology in wastewater treatment affecting the efficiency of biological nutrient removal. The right laboratory-prepared bugs are more efficient in organics removal-if they have the right growth environment. This efficiency is multiplied if microorganisms are allowed to grow as a layer-a biofilm-on specifically designed support media. In this way, optimized biological processing of a waste stream can occur

Site Specific Bacteria

Aeration and biofilms building are the key operational parameters that contribute to the efficient degradation of organic matter (BOD/COD removal). Over time the application specific bacteria become site specific as the biofilms develops and matures and is even more efficient in treating that site-specific waste stream. Dairy waste and human waste (as well as industrial waste) have a very specific makeup which is difficult to break down with indigenous bacteria. The huge quantities of nitrates, phosphorus, chemicals and salts along with odor causing sulfates necessitate the addition of very specific bacteria's to break down the unique makeup of waste. This is combined with the oxygen enhanced aeration system. Efficient processing of waste is therefore a cost saving opportunity in operations that will facilitate the dairies / waste water facilities passing of all Air Quality and EPA standards and be able to remain in business.

Glossary

ACIDIC
Acid forming.

AEROBIC BACTERIA
Bacteria that is living, active, or occurring only in the presence of oxygen, nitrates and nitrites.

ANAEROBIC BACTERIA
Bacteria that live and reproduce in an environment containing no "free" or dissolved oxygen. Anaerobic bacteria obtain their oxygen supply by breaking down chemical compounds which contain oxygen, such as sulfate (SO4).

ANION
Atom or group of atoms carrying a negative charge. The charge results because there are more electrons than protons in the anion. Anions can be formed from nonmetals by reduction (see oxidation and reduction) or from neutral acids (see acids and bases) or polar compounds by ionization. Anionic species include Cl^- , SO_4^{--} , and CH_3COO^- . **(Carbon Dioxide and Sulfates)** Highly colored intermediates in organic reactions are often radical anions (anions containing an unpaired electron). Salts are made up of anions and cations

BOD
Biochemical Oxygen Demand. The rate at which microorganisms use the oxygen in water or wastewater while stabilizing decomposable organic matter under aerobic conditions. In decomposition, organic matter serves as food for the bacteria and energy results from its oxidation.

BACTERIA
Living organisms, microscopic in size, which consist of a single cell. Most bacteria utilize organic matter for their food and produce waste products as the result of their life processes.

BIO-DEGRADATION
The process of bacteria breaking down a wide variety of compounds to obtain energy and materials for growth.

CATALYST
A substance that initiates a chemical reaction.

CATION
Atom or group of atoms carrying a positive charge. The charge results because there are more protons than electrons in the cation. Cations can be formed from a metal by oxidation (see oxidation and reduction), from a neutral base (see acids and bases) by protonation, or from a polar compound by ionization. Cationic species include Na^+ , Mg^{++} , and NH_4^+ . (**Calcium, Magnisium, Potassium)** The cations of the transition elements have characteristic colors in water solution. Salts are made up of cations and anions

CAUSTIC
Capable of destroying or eating away by chemical action; corrosive.

COD
Chemical Oxygen Demand. A measure of the oxygen-consuming capacity of inorganic and organic matter present in wastewater. COD is expressed as the amount of oxygen consumed from a chemical oxidant in mg/L during a specific test. Results are not necessarily related to the biochemical oxygen demand because the chemical oxidant may react with substances that bacteria do not stabilize.

COMBINED SEWER
A sewer designed to carry both sanitary wastewaters and storm-water or surface-water runoff.

COMPOUND
A pure substance composed of two or more elements whose composition is constant. For example, table salt (sodium chloride-NaCl) is a compound.

DO
Dissolved Oxygen. The atmospheric oxygen dissolved in water or wastewater.

DEGRADATION
The conversion of a substance to simpler compounds. For example, the degradation of organic matter to carbon dioxide and water.

RETENTION TIME
The time required to fill a tank at a given flow, or the theoretical time required for a given flow of wastewater to pass through a tank.

EFFLUENT
Wastewater or other liquid (raw, partially treated or completely treated) flowing from a basin, treatment process, or treatment plant.

ENZYMES
Organic substances which are produced by living cells and speed up chemical changes.

FACULTATIVE BACTERIA
Bacteria that can use either molecular (dissolved) oxygen or oxygen obtained from food materials such as sulfate or nitrate ions. Facultative bacteria can live under aerobic or anaerobic conditions.

FILTER MEDIA
Sand and stones.

FLOC
The aggregation of a number of fine suspended floating particles.

FOG
Fats, oils, and greases.

FORCE MAIN
A pipe that conveys wastewater under pressure from the discharge side of a pump to a point of gravity flow.

GRAVITY MAIN
A sewer line that runs downgrade. Water is pushed by gravity.

HYDROGEN SULFIDE (H2S)
A gas with a rotten egg odor. This gas is produced under anaerobic conditions. Hydrogen sulfide is particularly dangerous because after a while it dulls the sense of smell. The odor is also not noticeable in high concentrations. This gas is very poisonous to the respiratory system. It is explosive, flammable and colorless.

INOCULATE
To introduce a seed culture into a system.

INORGANIC WASTE
Waste material such as sand, salt, iron, calcium, and other materials which are only slightly affected by the action of organisms. Inorganic wastes are chemical substances of mineral origin; whereas organic wastes are chemical substances usually of animal or plant origin.

LEACH
To subject to the action of percolating liquid in order to separate the soluble compounds.

LIMONENE
A widely distributed terpene hydrocarbon that occurs in essential oils (such as oranges and lemons) and has a citrus odor.

MICROBE
A microorganism.

MICROBIAL
Pertaining to microorganisms.

NUTRIENTS
Substances which are required to support living plants and organisms. Major nutrients are carbon, hydrogen, oxygen, sulfur, nitrogen and phosphorous. Nitrogen and phosphorous are difficult to remove from wastewater by conventional treatment processes because they are water soluble and tend to recycle.

ORGANIC
Relating to or derived from living organisms.

ORGANIC WASTE
Waste material which comes mainly from animal or plant sources. Organic waste generally can be consumed by bacteria and other small organisms. Inorganic wastes are chemical substances of mineral origin.

PACKAGE TREATMENT PLANTS
A small wastewater treatment plant often fabricated at the manufacturer's factory, hauled to the site, and installed as one facility. The package may be either a small primary or a secondary wastewater treatment plant.

PATHOGENIC ORGANISMS
Bacteria, viruses or cysts which can cause disease (typhoid, cholera, dysentery). There are many types of bacteria which do not cause disease and which are not called pathogenic. Many beneficial bacteria are found in wastewater treatment processes actively cleaning up organic wastes.

PERCOLATION
The movement of flow of water through soil or rocks.

POLISH
To bring to a highly developed, finished, or refined state.

SANITARY SEWER
A sewer intended to carry wastewater from homes, businesses, and industries. Storm-water runoff should be collected and transported in a separate system of pipes.

SCUM
Extraneous matter or impurities risen to or formed on the surface of a liquid often as a foul filmy covering.

SEPTIC
A condition produced by anaerobic bacteria. If severe, the wastewater turns black, gives off foul odors, contains little or no dissolved oxygen and creates a heavy oxygen demand.

SLUDGE
Settled solid matter produced by water and sewage treatment processes.

SOLVENT
A substance (usually liquid) capable of dissolving or dispersing one or more other substances.

STORM SEWER
A separate sewer that carries runoff from storms, surface drainage, and street wash, but does not include domestic and industrial wastes.

SURFACTANT
Abbreviation for surface-active agent. It is the active agent in detergents that possesses a high cleaning ability.

TRUNK SEWER
A sewer that receives wastewater from many tributary branches or sewers and serves a large territory and contributing population.

VIABLE
Capable of living.

WET WELL
A compartment or room in which wastewater is collected. The suction pipe of a pump may be connected to the wet well or a submersible pump may be located in the wet well.