

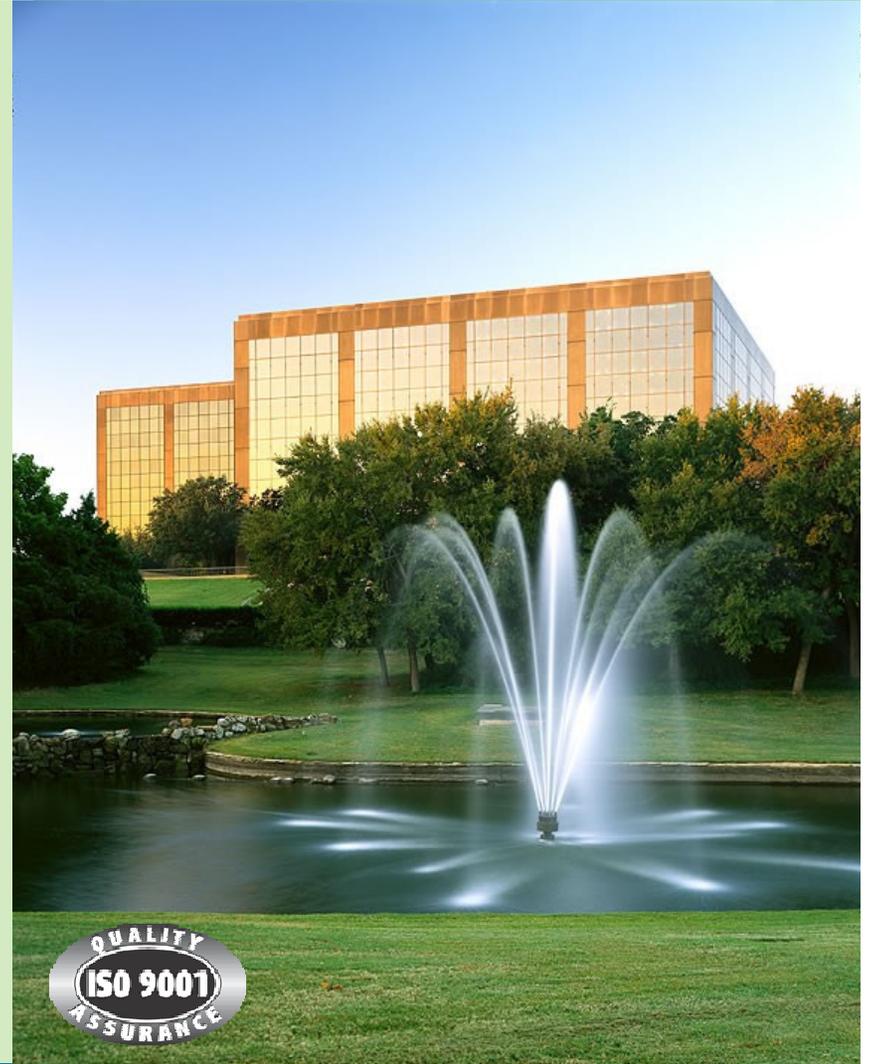


Microbiology 101 and the Benefits of Bio-Augmentation

Welcome

Chemsearch Company History

- **Privately held business founded in 1919**
- **Headquartered in Irving, Texas**
- **Operates in over 62 countries**
- **Manufacturer, provider and distributor of industrial, commercial, and institutional maintenance chemicals, products and services**
- **Over 1,000 technical representatives throughout North America**



Agenda | Understanding Microbiology

- **The HYPE**

- Microbiology 101
- What biologicals do/don't do
- The benefits of bio-augmentation

- **The HOOK**

- Differences in existing products
- Applications

- **The HOPE**

- Latest trends in biological treatment
- Local successes
- Questions and comments



THE HYPE

Powders and liquids...

Enzymes and bugs...

What's the difference?

Do they work? Opinions are based off experience. But why the continued debate for over 30 years?



Microbiology 101

•What are Enzymes?

- Proteins produced by bacteria and put outside their cell walls (**knife & fork of bacteria**)
- Act like scissors cutting large food sources into small pieces that are brought into the cell for bacteria to digest
- Enzymes are “used up” when they breakdown food sources

NOTE: Some products contain Enzymes ONLY! Municipalities sometimes forbid use of Enzyme-only products because they simply emulsify grease & oil that later reform in City mains.



Microbiology 101

- **What are Bacteria?**

- Single cell organisms that grow just like humans (consume food for nutrients and energy)
- They are Enzyme factories - producing enzymes, that are required to breakdown available food sources (carbon) on demand



Microbiology 101

Common enzymes produced by bacteria for FOG consumption:

- **Amylase** - Breaks down of carbohydrates (**starches – potato, bread, cereal, rice, pasta**)
- **Protease** - Breaks down proteins (**meat, fish, beans, eggs, nuts**)
- **Lipase** - Breaks down cooking oils and fats (**FOG**)
- **Cellulase** – Acts on cellulose



Microbiology 101

- Bacteria only produce the enzymes necessary to break down the available food source. If proteins are available, bacteria will produce protease. If carbohydrates are available, bacteria will produce amylase.
- There is great advantage to using bacterial products instead of enzyme-only products.
- **THERE ARE PRODUCTS AVAILABLE CONTAINING NO “FREE ENZYMES”**

Microbiology 101

- How do Bacteria Multiply?
 - Each cell divides in half to produce 2 cells (bacteria)
 - Thus $1=2$, $2=4$, $4=8$, $8=16$, etc. (Exponential Growth)
 - **Aggressive strains of bacteria double every 20 minutes**
- There are 4 stages of growth
 - **LAG** Cells power up & become active
 - **Exponential Growth** Active multiplying (doubling)
 - **Stationary** Not enough food - cells stop growing
 - **Death** No food > Starvation > Death
- Most biological treatments add “bugs” during LAG stage (Spore)

Microbiology 101

Aerobic vs. Anaerobic Growth

- **Aerobic** - utilize oxygen to grow
- **Anaerobic** - cannot live in oxygen environment
- **Facultative Anaerobes** - can live with/without oxygen

Aerobic growth is 10 times faster than anaerobic growth under ideal conditions

Spore vs. Vegetative Cell

- **Spore** - dormant in hard protective shell, takes 4-6 hours to become active and growing
- **Vegetative** - active, living bacteria (hungry NOW), able to start degrading waste immediately



Microbiology 101

BENEFIT OF ACTIVE BACTERIA CELLS

Introducing bacteria in the Exponential Growth stage results in “seeding” a waste stream with beneficial, actively growing bacteria.

Bacteria will grow into large numbers in the waste stream as they consume organic waste.

More bug bodies = More waste consumed

Microbiology 101

Enemies of Bacteria

- High Temperatures – Bacteria grow best between 68°F-92°F (Optimum temperature for growth = 87°F)
- Bleach, Disinfectants, Cleaners, Harsh chemicals, Toxic compounds – lethal to bacteria
- Lack of water (low water activity) – bacteria must have water to live and grow
- Changing environments – **frequent treatments of high numbers of bacteria is important**

Microbiology 101

- Bacteria Convert Organic Matter to CO_2 and H_2O

Microbiology 101

Why Do Biological Treatments Have Short-Comings?

- Not enough microbes applied
- Wrong microbes
 - Inactive microbes
 - Inefficient enzyme producers
 - Unable to digest fatty acids –
Natural by-product of grease
break-down
- Applied at the wrong time
- Activity limited by high temperatures, disinfectants, detergents, etc.
- Not applied frequently enough
- Lack of RETENTION TIME



Importance of Fatty Acid Degradation

- **Traditional Products**

- Grease (Lipids)  + 3 Fatty Acids
- (1) Glycerol  Carbon Dioxide + Water
- (2) Fatty Acids  pH ↓

- **Vegetative Cells**

- Grease (Lipids)  + 3 Fatty Acids
- (1) Glycerol  Carbon Dioxide + Water
- (2) Fatty Acids  Carbon Dioxide + Water

Microbiology 101

- **MORE RETENTION TIME = MORE DEGRADATION**
- **NEED ALL THE RETENTION TIME POSSIBLE**
- **REMEMBER – IF BACTERIA ARE GROWING, THEY ARE CONSUMING CONTAMINANTS!**

THE HOOK

- What kinds of “bacterial” products are available on the market today?
 - Liquids (Spore-form)
 - Powders (Spore-form)
 - Solid Blocks or Pellets (Spore-form)
- What can Spore-form bacteria products do for you?
 - Not much in most instances.
 - Most facilities don’t have adequate retention time to reap the benefit of most bacterial products
 - In facilities that do have adequate retention time, 4-6 hours is used in LAG phase. The remainder of retention is spend growing bacteria to high numbers to properly digest FOG.

COMMON APPLICATIONS

- DRAIN SYSTEMS/GREASE INTERCEPTORS
 - Liquids – slug feed or drip systems
 - Powders – manually applied



COMMON APPLICATIONS

- LIFT STATIONS
 - Liquids – slug feed or drip systems
 - Powders – manually applied
 - Solid Blocks or Pellets – suspended from top



THE HOOK

- Most objections to biological treatment can be addressed with a simple solution
 - Vegetative bacteria

It's been determined that most facilities don't have the retention to support LAG phase bacteria and low numbers of microbes.

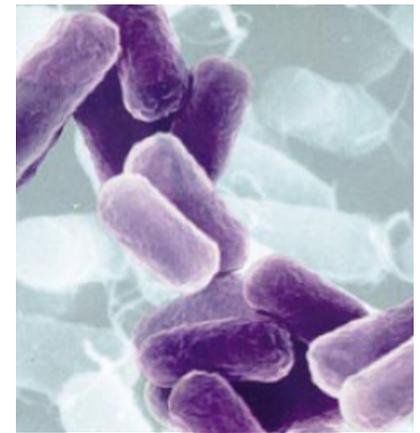
To introduce live bacteria in the exponential growth stage can properly address the breakdown organic material.



THE HOPE

The Bio-Amp™ System is the most effective biological dispensing technology available

- **The system is the result of 8+ years of research**
- **Bio-Amp™ is a patented onsite microbial growth system which regularly discharges active bacteria into the wastewater stream every 24 hours**



BIO-AMP ENGINEERING

The Bio-Amp™ is a programmable, self-contained unit which automatically dispenses bacteria into the wastewater stream

- **Programmable Operation** - The Bio-Amp™ growth cycle can be programmed to fit your operations schedule
- **Proven Reliability** - The Bio-Amp™ 's reliability has been proven with almost 100 million logged working hours
- **Compact Size** - The Bio-Amp™ easily mounts on the wall, in space constricted locations (18.5"W x 28.5"H x 9.25"D)
- **Standard connections** - Unit connects to a standard hose bid and 110V electrical outlet



Battery backup - Battery maintains units settings during power outages

Back-flow prevention - Meets standard plumbing code to ensure biologicals do not enter the fresh water supply

Overflow protection - Unit will automatically shut-off if any leakage occurs

No Maintenance required by the customer

BIO-AMP MICROBIOLOGY

The Bio-Amp™ uses bacteria strains specifically developed to reduce FOG in wastewater effluent

- Bio-Amp™ dispenses 30 trillion bacteria each day
- That is equivalent to 5 – 55 gallon drums of liquid product or 17-25 pounds of dry bacteria everyday
- Bio-Amp™ utilizes bacteria which thrive in both aerobic and anaerobic conditions
- Five strains of bacteria enable the Bio-Amp™ to effectively treat a broad range of organic waste
 - Sugars
 - Animal fats
 - Proteins
 - Carbohydrates
- Two strains of *Pseudomonas* bacteria have been developed to aggressively breakdown oils and grease
- Bacteria strains contain no chemicals, surfactants, or free-enzymes and are guaranteed to be free of Salmonella and E-Coli

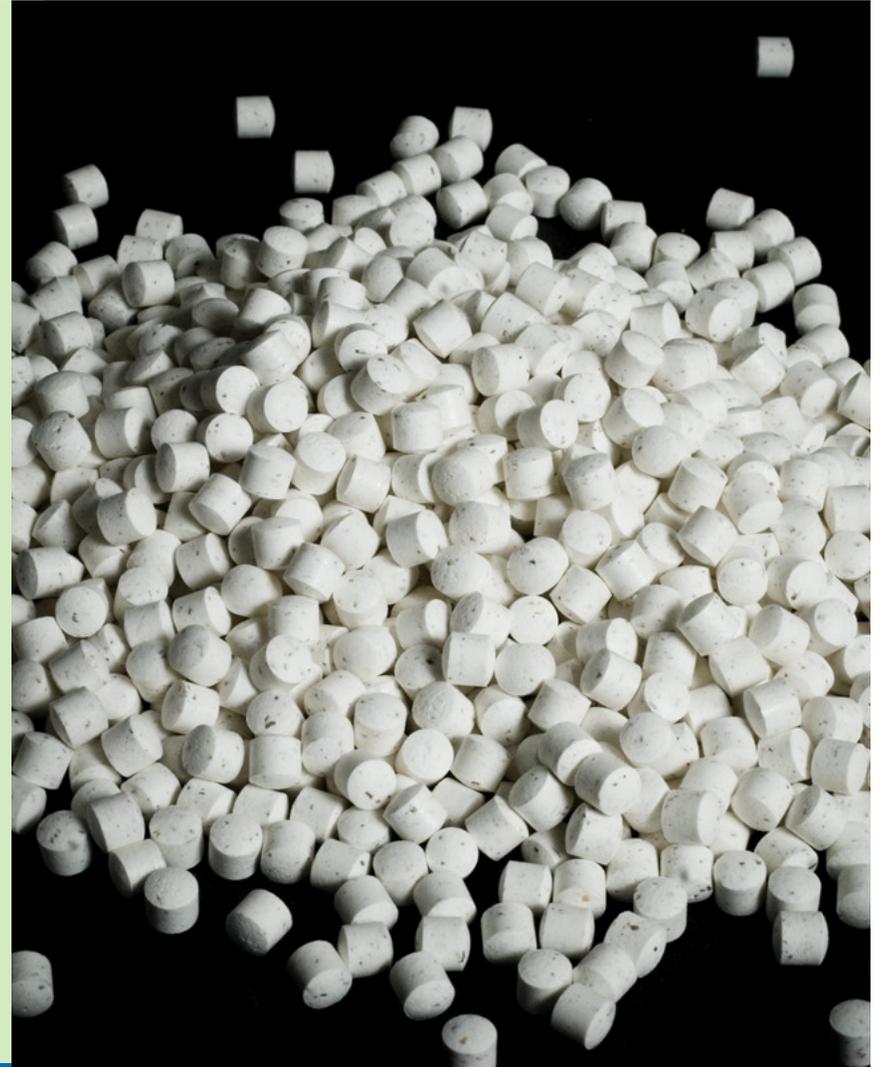


BIO-AMP BACTERIA SELECTION

BIO-Amp System Microbe Selection – *Bacillus*

The BIO-Amp utilizes 3 strains of Bacillus spores. Enzymes produced by these strains:

- *Protease*
- *Amylase*
- *Cellulose*
- *Lipase*



BIO-AMP BACTERIA SELECTION

BIO-Amp System Microbe Selection – *Pseudomonas*

***The BIO-Amp utilizes 2 strains of
Pseudomonas spores. Enzymes
produced by these strains:***

- ***Lipase***

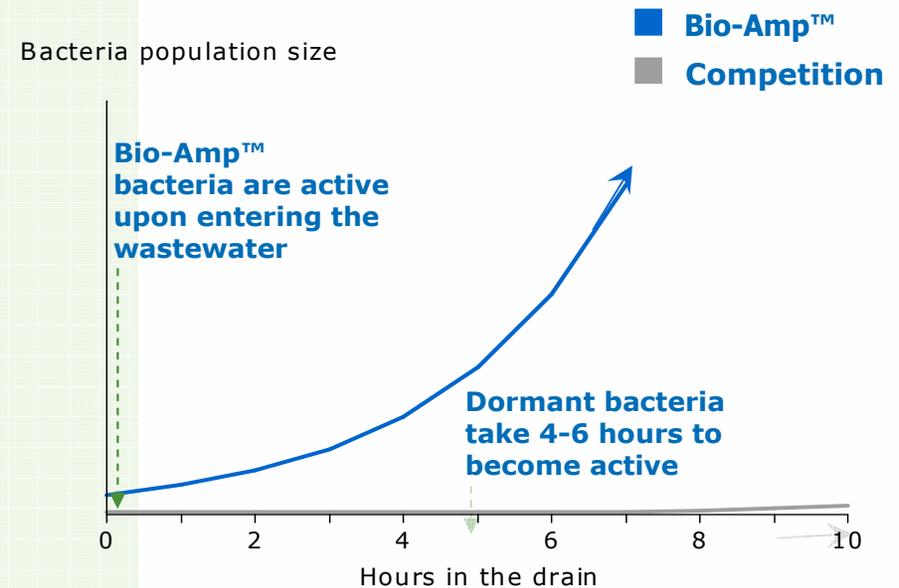
Pseudomonas have very diverse, multiple enzyme systems that allow them to degrade compounds, such as, alcohols, fatty acids, amines, amides, hydrocarbons, and other complex organic compounds. Pseudomonas are able to degrade hundreds of organic compounds



ACTIVE VS. SPORE BACTERIA

The Bio-Amp™ discharges active bacteria, meaning the bacteria begin feeding and multiplying the instant they enter the wastewater stream

- **Traditional biological products require 4-6 hours for the bacteria to come out of their dormant state**
- **In many cases facilities don't have 4-6 hours of retention time in their systems**
- **The Bio-Amp™ allows bacteria to become active during the growth cycle, enabling the bacteria to enter the wastewater in an active state**



With traditional treatments, most bacteria get flushed through drain system before they even become active

LOCAL APPLICATIONS

- **University of New Hampshire**

The Bio-amp has significantly reduced the FOG's (Fats, oils and grease) in our kitchen areas at UNH, Durham. We have also implemented a drain maintenance program once a month with my night staff which compliments the BIO-Amp in reducing the odors, drain flies and any grease reaching the main lines to the waste water plant in town.

Thomas H Smith
Sr.Facilities Manager

Facilities and Operations
6 Leavitt Lane
Durham, NH 03824



QUESTIONS

