# SEPT-X®

## Waste Water Treatment Biotechnology Solution

## PART I

Developed by

BNA
BioNatural America
INSTITUTE

BNA
BioNatural America
INSTITUTE
MADE IN AMERICA

# What is SEPT-X?

**SEPT-X** is a revolutionary combination of human and environmentally friendly active micro-organisms creating a powerful cocktail of beneficial enzymes, super catalyzing co-enzymes and co-factors with remarkable ability to fully digest a wide range of compounds and sanitize the environment.

It is a natural 100% organic, bio-degradable culture without harsh chemicals or residues.

**SEPT-X™** rapidly digests fats, protein, carbohydrate, cellulose, and a wide range of pollutants leaving the environment in natural balance.

# The World's Most Powerful Enzyme Technology

The power of SEPT-X is a newly discovered naturally occurring enzyme known as 'Super Catalase'.

This cultured protein creates a Kinetic Rate Increase for all other enzymes of 1,000's to 100,000's of thousands of times their normal rate of catalysis.

For example:

| Enzyme Type | Natural Kinetic Rate | SEPT-X Rate Enhancement |
|---|---|---|
| Lipase | 5,000 / sec | 10M / sec |
| Protease | 25-30K / sec | 1 Billion+ / sec |

This ability to enhance natural biochemical reaction speed makes SEPT-X effective in many applications where previously no solution existed.

Combined with the broad spectrum enzyme formulation, pediocins, iturins and killer toxins, our Kinetic Rate Enhancement makes SEPT-X products much more effective than any other technology in a wide rage of applications.

# Core Capabilities

Rapidly Degrade & Fully Digest Non-Living Organic Matter

Anti-Microbial

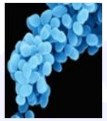
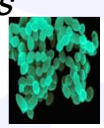
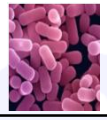

Anti-Fungal

Toxin Neutralization

# Production Process

1. Pure cultures are kept in secure bio-resource centers in USA
2. 11 microbes (bacteria & yeast) are the core ingredients
3. In a multi-stage culturing and fermentation process, under tightly controlled conditions, the pure SEPT-X™ culture is created
4. 6 of the 11 microbes are fully metabolised in the production process
5. Vacuum freeze drying places the culture into a dry live cell state
6. The Live Cell Powder reactivates within minutes in the presence of moisture

# SEPT-X™ Microbe Functionality

| Microbe | Description | Function |
|---|---|---|
| *Pediococcus acidilactici*  | Produces Lactic acid & Pediocins to: | **inhibit growth of gram negative bacteria;** Vibrio cholerae, Salmonella sp., Pseudomonas sp., E.coli, Clamphylobacter) etc. **inhibit growth of gram positive bacteria:** Clostridium botulinum, Clostridium perfringens,Staphylococcus aureus, Listeria monocytogens |
| *Pediococcus pentosaceus*  | Produces Lactic acid & Pediocins to: | **inhibit growth of gram negative bacteria:** Vibrio cholerae, Salmonella sp., Pseudomonas sp., E.coli, Clamphylobacter etc. **and inhibit growth of gram positive bacteria as:** Clostridium botulinum, Clostridium perfringens, Staphylococcus aureus, Listeria monocytogens |
| *Bacillus amyloliquefaciens*  | Produces Enzymes to: | **break organic matter into smaller molecules:** Amylase, Lipase, Protease, Peptidase, Sucrase |
| | Produces: Iturins (Antifungal) | **to inhibit growth of fungi including:** Fusarium, Collectotricum, Rhizoctonia, Aspergillus, Phytopthera |
| *Pichia farinosa*  | Yeast rarely found in nature | **creates Toxins Killer to inhibit the growth of yeasts and neutralizes a wide range of toxins:** Aflatoxins, Mycotoxins, Endotoxins, Exotoxins, etc |
| *Dekkera anomala*  | Spoilage Beer Yeast: | **ferments carbohydrate, starch and sugar into Acetic acid without alcohol and produces enzymes:** Cellulase, Hemicellulase, Xylanase, Cellubioase, Amylase, Pectinase, Lignase, Arabinase etc |

# SEPT-X™ is Non-Toxic

**Group of Human and Environmental Friendly Microorganisms are very Safe!**
**LD50 > 21,000 mg/kg**

| Microorganism | SEPT-X Concentration | W.H.O. - Safety Level |
|---|---|---|
| Pediococcus sp. | 3 x $10^8$ cfu/g | Bio-safety Level 1 |
| Bacillus sp. | 6 x $10^7$ cfu/g | Bio-safety Level 1 |

| | | |
|---|---|---|
| Pichia sp. | 5 x $10^7$ cfu/g | Bio-safety Level 1 |
| Dekkera sp. | 3 x $10^7$ cfu/g | Bio-safety Level 1 |

# Operative Conditions

**Effective in wide range of conditions**

- pH 1.5 to 9.6
- Low oxygen content (0.5 ppm) – Facultative Anaerobe
- Wide range of salinity conditions (up to 65,000 ppm)
- Temperature tolerance (0-65 degree Celsius)
- Antibiotics (up to 30 ppm)
- Copper (up to 5 ppm)
- Chlorinated water (up to 10 ppm)

# Water Treatment Outcomes

- Effective at very low dosages
- Proven ability to rapidly reduce:
    - BOD (Biological Oxygen Demand)
    - COD (Chemical Oxygen Demand),
    - TDS (Total Dissolved Solids)
    - Turbidity & SS (Suspended Solids)
    - TKN (Total Nitrogen, including Ammonia, Nitrates, Nitrites )
    - Phosphorous
    - Oils & Grease,
    - Faecal Coliforms
    - Many chemical pollutants
    -Removes Blue Green Algae

# SEPT-X™ Enhancement

SEPT-X™ improves WWTP operations across many key parameters through a substantial improvement in enzymatic efficiency

| | Enzymatic Efficiency | Microbial Load | Organic Load | Dissolved $O_2$ | Aeration Requirement | Sludge Volume |
|---|---|---|---|---|---|---|
| Current Operations | Low | High | Slow Removal | Low | High | High |
| SEPT-X™ Enhancement | Very High | Low | Rapid Removal | High | Low | Low |

# WWTP Potential Results

Typical expected results from Industrial / sewage treatment

- Increase Dissolved Oxygen (DO) from 2ppm to 4-6ppm
- Reduce electricity consumption for aeration of 50-60%
- Sludge reduction 80-90%
- No requirement for downstream disinfection / sanitisation
- Anaerobic – 80% reduction in $BOD_5$ in 3 days
- Aerobic – 98-99% reduction in $BOD_5$ in 3 days
- Simplified operations

# Waste Water Treatment

Key Benefits:

1. Increased operational stability, more predicable results, simplified plant operations
2. Improved Environmental outcomes
3. Reduced operating costs
4. Capacity increases / Potential reduced capex
5. Suitable for all existing treatment plants and processes (excluding RO)

# Improved Operations

- Wide operative conditions of SEPT-X microbes reduce plant variability
  - Odour
  - Sanitation
- Speed of catalysis
- Reduced risk of Biomass washout or loss
- Process simplification after implementation
  - Predictability ultimately justifies reduced monitoring
  - Chemicals management

# Improved Environmental Outcomes

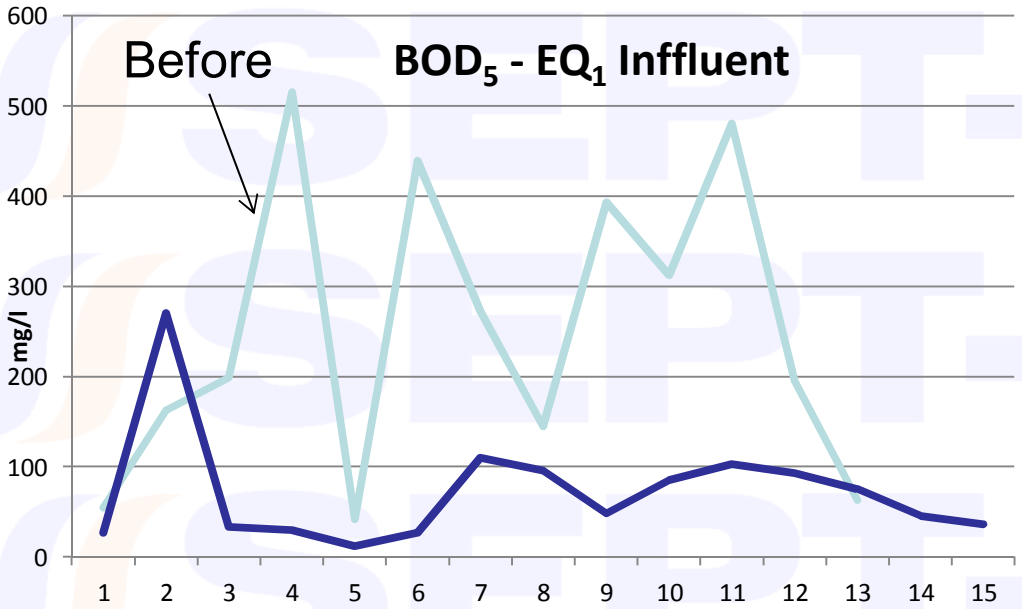
- Odour Control
- Reduced sludge to landfill / incineration
  - Bio-solids processing – improved quality (pathogens, herbicides, pesticides, metals)
- Reduced sludge transportation energy costs
- Reduced electricity usage
- Improved biogas generation
- Reduced chemical usage
- Improved final discharge, (TKN, P)
- Improved emissions from tertiary ponds ($NO_2$, $NO_3$)

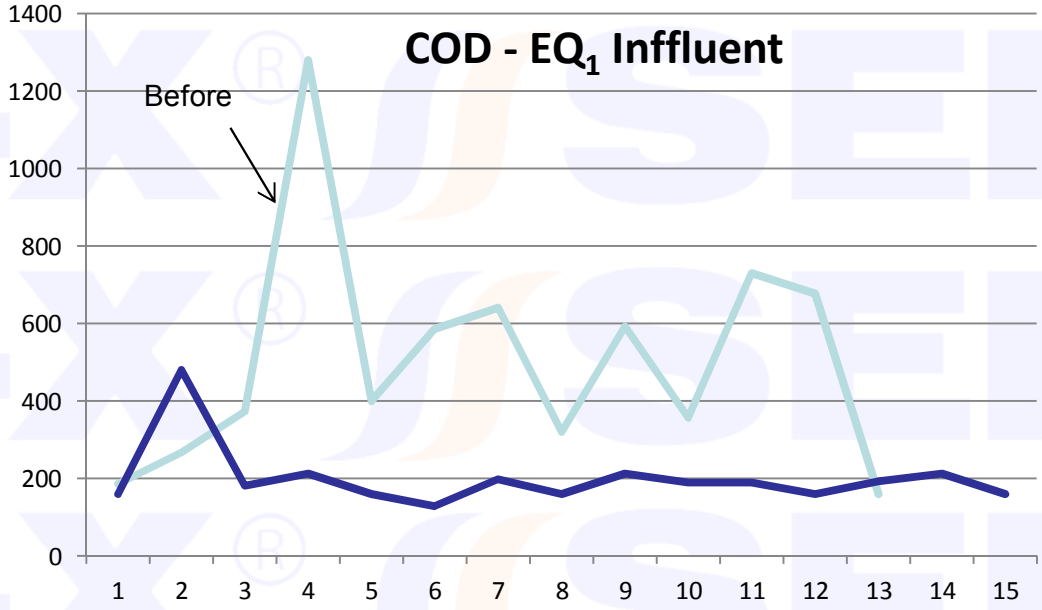
# Reduced Operating Costs

- Electricity
- Chemical usage
- Sludge disposal
- Sludge transport
- Labour
- Capex for capacity increases
- Potential Green House Gas credit

# Example – Industrial WWTP

- The following data is from the initial 14 days of dosing SEPT-X™



# Disinfection

- SEPT-X™ can remove & limit growth of:
  - Harmful pathogenic bacteria including -

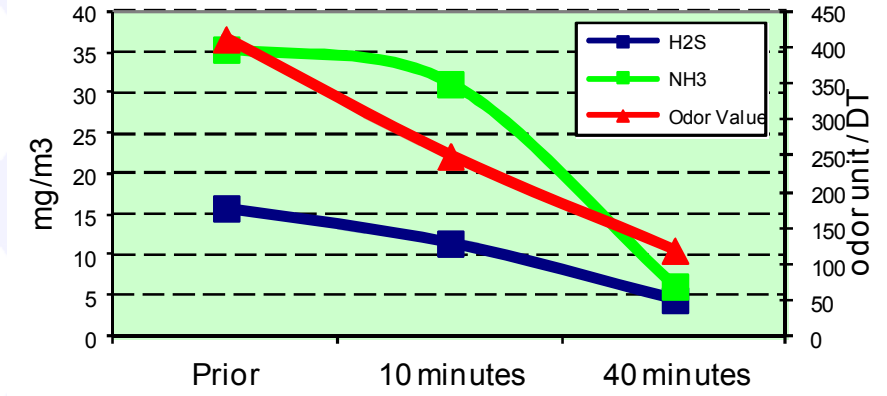
    Vibrio cholerae,
    Clostridium perfringens,
    Listeria monocytogens
    Pseudomonas sp.,
    Clamphylobacter
    Clostridium botulinum,
    Staphylococcus aureus
    Salmonella sp.,
    E.coli,

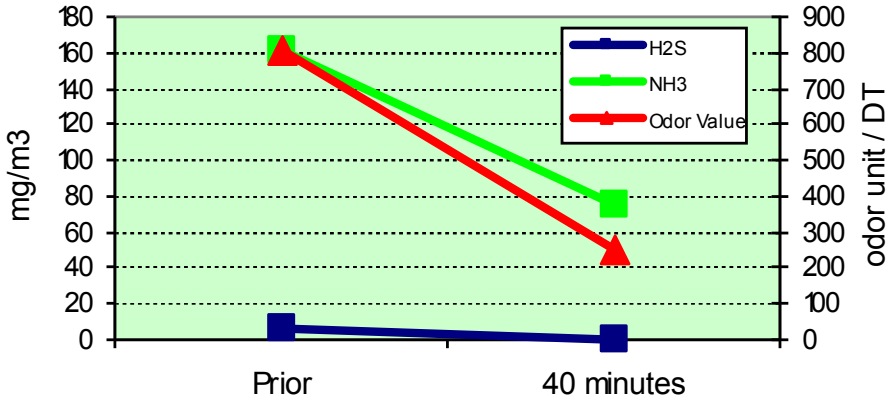
  - Fungal growth
- **Chemical disinfection** requirements are <u>minimized or eliminated</u>

# Odour Removal

| Liquid Stream | | | |
|---|---|---|---|
| **Sample** | **$H_2S$** ($mg/m^3$) | **$NH_3$** ($mg/m^3$) | **Odor Value** (odor unit / DT) |
| Prior | 15.8 | 35.4 | 412 |
| 10 minutes | 11.5 | 31.1 | 250 |
| 40 minutes | 4.49 | 6.15 | 119 |

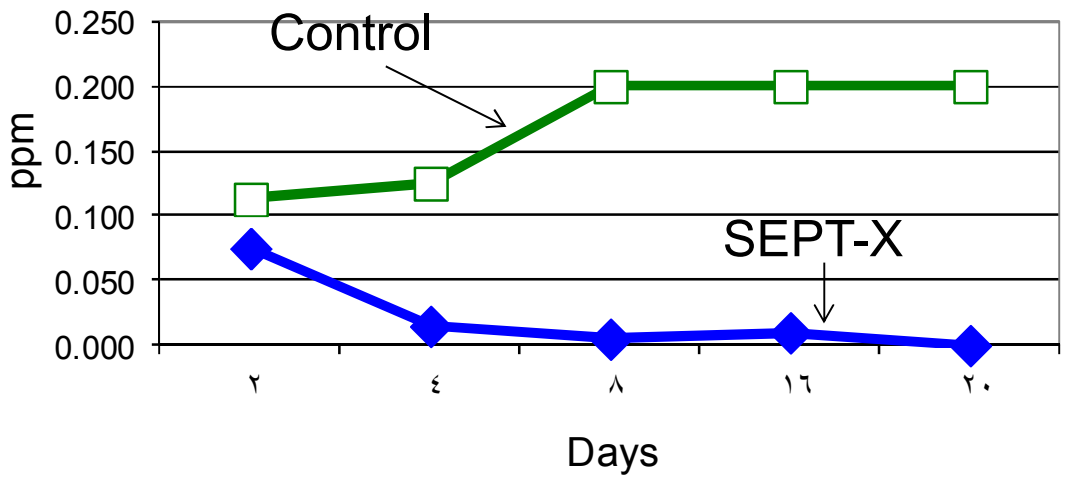
| Solid Stream | | | |
|---|---|---|---|
| **Sample** | **$H_2S$** ($mg/m^3$) | **$NH_3$** ($mg/m^3$) | **Odor Value** (odor unit / DT) |
| Prior | 6.32 | 161 | 810 |
| 40 minutes | 0.24 | 74.4 | 251 |



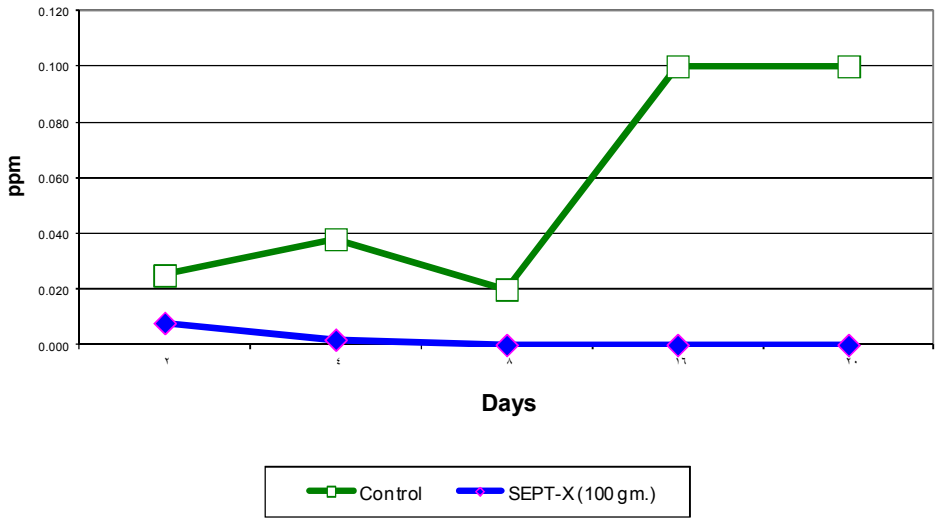
# $NH_3$ Removal

| Effectiveness on Ammonia Level | | | | | |
|---|---|---|---|---|---|
| | Ammonia level (ppm) from water detector water | | | | |
| | Checking Day | | | | |
| | 2 | 4 | 8 | 16 | 20 |
| Control | 0.113 | 0.125 | 0.200 | 0.200 | 0.200 |
| SEPT-X | 0.075 | 0.015 | 0.005 | 0.010 | 0 |



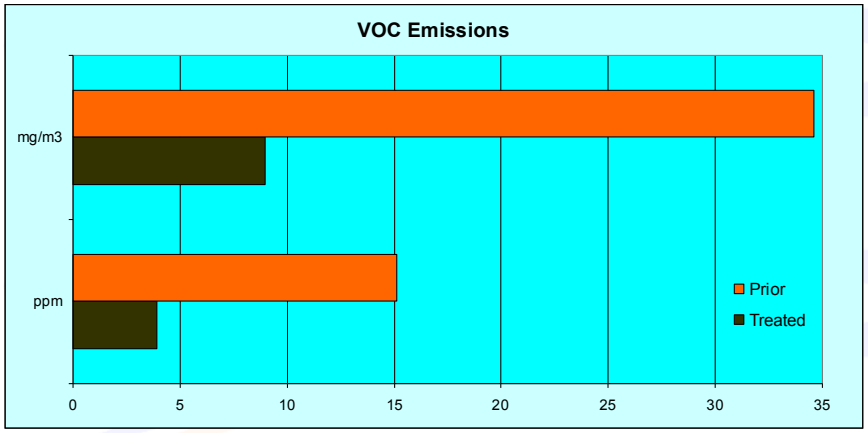
# $NO_2$ Removal

| Effectiveness on Nitrites Level | | | | | |
|---|---|---|---|---|---|
| | NITRITES level (ppm) from detector water | | | | |
| | Checking Day | | | | |
| | 2 | 4 | 8 | 16 | 20 |
| Control | 0.025 | 0.038 | 0.020 | 0.100 | 0.100 |
| SEPT-X-P | 0.008 | 0.002 | 0 | 0 | 0 |



# High Flow – Industrial Stack

- Drying airflow after pelleting in feedmill
- 24,000 cubic metres per hour airstream
- Wide range of VOC's including:
  - Mercaptans, Amines, Ammonia, Hydrogen
- Odour complaints were arising up to 20km in wet season
- SEPT-X™ used:
  - 1,000ppm (200gm into 200L of water)
  - 8 dispersion nozzles in spiral along 3m vent stack
  - 5L per hour of solution used
- Independent sampling & analysis by SGS
- 74% reduction in VOC emissions



# Biogas Production

**Increase methane production**

Tests in digester units (manure substrate) have shown $CH_4$ has been proven to increase by 35-40%. This substantially increases the energy production capacity and therefore economics of a biogas plant.

**Reduction in $CO_2$ emissions**

CO2 levels off-gassed during decomposition of organic wastes are reduced by 50-55%. This has a large and direct greenhouse gas emission benefit.

**Temperature**

Due to the rapid action of decomposition achieved by the **SEPT-X** microbes and resultant enzymes temperatures of approx 60° C are achieved. This further accelerates the bio-chemical reaction speed increasing effectiveness. Most natural enzymes could not tolerate this temperature.

**Sludge Reduction & Quality**

Due to the rapid decomposition capacity, **SEPT-X** will reduce the quantity of final sludge produced. Evidence suggests that this will be a 10-20% reduction over a 3 day total detention period in a digester relative to natural bacteria. In addition the quality of sludge in terms of contaminants, pathogens, odour etc will all be significantly improved.

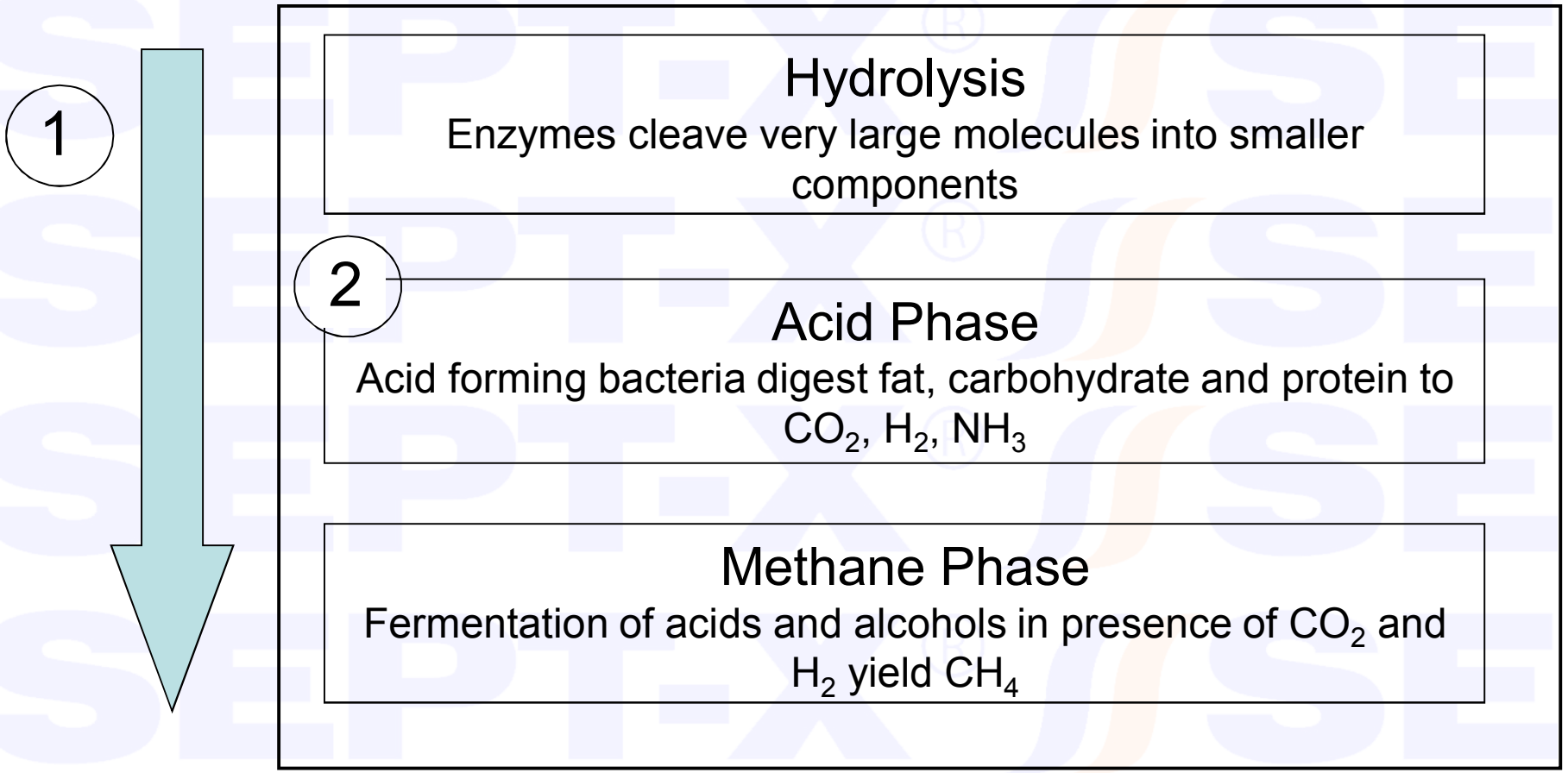
**Plant & Equipment**

Corrosion prevention in plant equipment due to removal of sulphides and breakdown of bio-films that harbour sulphide producing bacteria.

# Biogas – Anaerobic Digester Results

| Biogas | Increase | Decrease | Up to | Down to |
|---|---|---|---|---|
| $CH_4$ | 35 – 40 % | - | 60-65 % | - |
| $NH_3$ | - | 2-3 % | - | 0.1 % |
| $H_2S$ | - | 0.5-1.0 % | - | 0.01 % |
| $CO_2$ | - | 50-55 % | - | 30-35 % |

# Biogas – Chemistry of Digestion




1. SEPT-X rapidly accelerates digestion
2. SEPT-X alters phase transformation

# Biogas Chemistry

## SEPT-X™ Mechanism

AEROBIC (+$O_2$ )

$C_6H_{12}O_6N_2 \longrightarrow CO_2 + H_2O +$ ENERGY 38 ATP

ANAEROBIC

$C_6H_{12}O_6N_2 \longrightarrow$ 97% LACTIC ACID + 3% $CO_2 \longrightarrow 4CH_4 + 2CO_2$ + 13 ATP

## Natural Bacteria / Competitors

AEROBIC (+$O_2$ )

$C_6H_{12}O_6N_2 \longrightarrow CH_4 + NH_3 + CO_2 + H_2O +$ Minimal Energy

ANAEROBIC

$C_6H_{12}O_6N_2 \longrightarrow 2CH_4 + 4CO_2 + 13$ ATP

# Blue Green Algae Treatment

- Nutrient loads are reduced
- Effective & complete algal removal:
  1. Cyanobacterium cells are lysed
  2. Toxins are neutralised
  3. Cell material is rapidly digested without spiking BOD
- Result is:
  1. Rapid removal of blue green algal bloom
  2. Elimination of toxicity risk to animals, humans the environment
  3. Preservation of phytoplankton and the ecosystem

# Application-Pre Activation

- **Equipment**

1. 1 x 100 Liters Clean Tank
2. 2 x Fish Tank Air Pumps (recommended that each is to be equipped with 2-Air Outlets).
3. 1 x Fish Tank Cleaning Motors (Filters are to be completely removed).
4. 1 x Temperature Gauge.
5. 1 x pH Gauge.

- **Procedures**

1. Install the Fish Tank Cleaning Motor at the bottom of the tank (make sure the filters are completely removed).
2. Install the outlets of one of the Fish Tank Air Pumps at the bottom of the Water Tank.
3. Fill the Water Tank with 95 Liters of Standard Tap Water.
4. Keep the Fish Tank Cleaning Motors and the Fish Tank Air Pumps running for 120-minutes before applying the doze.
5. After 2-hours of continuous aeration to the water; a doze of 1000grams is to be applied for every 95 Liters of Water.

# Application-Pre Activation

1. Once the doze has been applied; the second Fish Tank Air Pump is to be applied to the tank.
2. After starting the 4th hour of the application of the product into the water; the pH value and the Temperature are monitored every hour.
3. Once the temperature starts rising above 30 degrees celsius; this is an indication that the solution is starting to reach the maturity time and thus both the pH and the temperature are to be monitored every 30-minutes and not every hour and the later applied Air Pump is to be stopped and only the pump at the bottom is to be kept running with the cleaning motor.
4. Once the pH value starts moving below 7 and/or the solution temperature starts reaching towards the 37 degrees celsius this means that the solution is in its prime condition and is to be applied to the media subject of treatment within a maximum of 1-hour and in this case the air pump is to be stopped once any of the above conditions (pH = 6 or temperature = 37 degrees) one of the 2-outlets of the Air Pump is to be removed.
5. If the solution reaches this condition and is kept unused for more than 2-hours the pH value will rise again which is an indication that some of the bacterial strains has started dying and thus the solution will lose a good portion of its efficiency.

# Application-Pre Activation

- **Special Cases**

1. The above referred conditions would usually take anywhere between 12-18 hours for completion of pre-activaiton depending on the quality of the pre-activating water; room temperature; and strength of the Air Pumps being used for aeration.
2. If in a special case; the pre-activation is required to be completed within a very short duration; 50mL of Glucose is to be added to the solution with the water filling at the beginning stage which will bring down the pre-activation time to be no more than 3-5 hours. However, this application makes the pre-activation procedure very aggressive and if the solution is not used quickly upon reach of the prime point we will lose multiple strains of the bacteria in the solution.

# Dosing

- Day1; 2PPM
- Day2; 1PPM
- Day3; 0.5 PPM
- Day 4 and then: 0.2 PPM
- For actual procedure and custom application kindly call our technical support

# Benefits

## Dosing System:

- Dosing of SEPT-X should take place as high upstream in the influent flow as possible. This allows for maximum contact time for the high speed enzymes to break down pollutant and nutrient molecules. It also allows maximum strength culture to be present in the aeration chamber.
- Simple two tank pre-activating dosing systems  are the most effective in introducing the technology into the influent. This represents a very minimal capital requirements and deliver the most economical results to plant operation. For very low flow plants the technology is applied by simply hanging the SEPT-X in filter bag in influent.
- in sewage operation, the optimal dosing point may be within collection network. Dosing at key rising mains or pumping stations throughout the collection system will result in substantially treated influent arriving at the treatment plant.

# Benefits

## Anaerobic tanks/Biological nutrient removal (BNR)

- When SEPT-X is used in a plant there is less reliance on processes such as BNR or anaerobic or anoxic chambers. These stages are introduced to assist with nutrient uptake by bacterial biomass. As the SEPT-X treatment technology is not dependent on uptake by bacterial biomass, the role for these stages is reduced. Their presence in stream are not however detrimental to SEPT-X as it operates effectively as a facultative anaerobic and will continue the action through anaerobic and anoxic stages.

# Benefits

## Phosphorus management

- Sewage treatment is principally about the removal of Nitrogen and Phosphorus nutrients from the influent as effectively as possible before discharge usually into a natural water course-either a river, lake or ocean. Efficient nutrient removal is essential to prevent eutrophication of waterways.
- Unlike nitrogen compounds which can be broken down and off-gassed as nitrogen gas (N2-See Nitrogen management), Phosphorus can not be converted into gaseous state for removal at temperatures in waste water environment. As a result, Phosphorus is most effectively treated in plants adopting SEPT-X technology through co-aggulationand Sedementation. The Phosphorus then is removed from the plant as phosphate. In large scale plants, this is commonly achieved through Alum Dosing.
- Whilst there has been a trend to BNR (Biological Nutrient Removal) in recent years targeting uptake of phosphorus by phosphorus favoring bacteria strain. The benefits of this are far outweighed by overall plant efficiencies that enzymatic treatment with SEPT-X offers

# Benefits

## Sequencing Batch Reactors (SBR)/Biological reactors

- Similar to RAS systems, a portion of activated sludge is retained in SBR tank. When SEPT-X is introduced to the plant it is recommended that 90-95% of tank volume is decanted in each batch. This retain a small quantity of low strength enzymatic inoculants sludge.

# Benefits

## Nitrogen managment

- Nitrogen is typically removed from waste water through a combination of uptake into bacterial cellular material, microbial digestion and sedimentation. Removed from the plant as a component of sludge the majority of the nitrogen then completes its transformation through the nitrogen cycle external of the plant.
- SEPT-X™ has the ability to enzymatically accelerate the completion of the nitrogen cycle to remove a large portion of nitrogen in the form of nitrogen gas (N 2) within the confines of the plant. This process requires amonification, Nitrification, Dentrification to ultimately break the nitrogenous compounds in influent into CO 2 (Carbon Dioxide), H2O (Water) and N2 (Nitrogen Gas).
- This action is evidenced by higher than normal in-process measures of ammonia, nitrites and nitrates demonstrating progressive break down of the nitrogenous waste at rates much faster than are otherwise possible. Despite these higher in-process measures,final effluent is typically lower in total nitrogen, ammonia and nitrate than traditional plant operations provides, due to the enhanced biological effecincy in the aeration chamber.

# Benefits

## Return Activated Sludge

- A very common technology process for waste water treatment is the use of return activated sludge. This process of re-circulating a highly cultured, mature microbial biomass has been the mainstay of nutrient removal in waste water treatment for several decades. This process not only reduces waste it also consumes substantial energy for aeration and creates the high bio-solids output of traditional plants.
- The SEPT-X™ high speed enzyme technology changes the role of the RAS technology in the plant process and operation. RAS is no longer required to re-circulate a high volume of biomass when SEPT-X ™ is added into a plant as the plant no longer relies on the biomass to remove nutrients as this is done enzymatically. In-process measures of quality, through an activated sludge plant, typically shows a worsening of quality prior to improvement, due to the reintroduction of the concentrated activated sludge. This inherent inefficiency can be avoided if the raw influent can be treated without the addition of activated
- sludge however previous technologies have failed to achieve adequate nutrient removal.
- When using SEPT-X™ - Aqua, best results are achieved by allowing the high speed enzymes to operate as effectively as possible by not re-introducing nutrient, biomass or contaminants back into the waste stream. In process terms, this means wasting all accumulated sludge and biomass from the system shortly after the introduction of SEPT-X™. Thereafter the plant operates enzymatically. At this time the RAS system is employed to return approximately 5% of inflow volume to assist with enzymatic innoculation.

# Benefits

## Sludge Reduction

- Sludge is removed from the operation as filter cake (industrial) or bio-solids (sewage). In certain industrial treatment plants, the biological activity is often low due to the type of contaminant being treated, and as a result of low resonance times. Filter cake is a result of high coagulation and flocculation  additives utilized to remove suspended solids and contaminants. The SEPT-X™ enzymes rapidly remove the contaminants at the molecular level including many suspended solids, hence the need for flocculation and coagulation is substantially reduced, resulting in reduced filter cake volume.
- In sewage treatment and some industrial processes, the majority of bio-solids produced are dead bacterial cells that were formed to remove the nutrients (carbon, nitrogen, phosphorus etc) from the sewage through microbial digestion for energy and in the creation of new bacterial cellular material. As a high speed enzyme technology,
- SEPT-X™ does not rely on a biomass to remove the nutrients, solids and contaminants. The second source of bio-solids is residual contaminant material. Through its high speed action, SEPT-X™ achieves a higher removal rate of this waste. In combination this enables SEPT-X™ - Aqua to achieve bio-solids reductions of up to 95%.

# Benefits

## Energy Savings

- Waste water treatment typically requires high levels of aeration to sustain suffient oxygen levels to support high levels of biomass and oxidization of waste material. This high oxygen demand leads directly to high electricity consumption for aeration.
- By removing the reliance on biomass to remove nutrients and contamination, oxygen demand is substantially and rapidly reduced. The key contributors to the reduced oxygen demand are reduced microbial respiration due to lower levels of biomass, rapid removal of organic waste hence lower oxidization demand, lower microbial cell formation. The result of this is a natural increase in dissolved oxygen (DO) levels. Where employed, auto DO monitoring equipment will manage aeration allowing for SEPT-X™ technology to deliver energy savings often in excess of 50%. Where such technology is not employed, manual monitoring and adjustment of aerator run time and speed are required to realize energy savings.
- This not only provides direct cost savings to the plant but may offer options to generate carbon credits or obtain other forms of incentive for the adoption of energy saving technologies.