

NEW

(Neutral Electrolyzed Water)

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List of Abbreviations

COSHH	Control of Substances Hazardous to Health Regulations
ECA	Electro-Chemical Activation Technology
EPA	Environmental Protection Agency
FAC	Free Available Chlorine
FIFRA	Federal Insecticide Fungicide and Rodenticide Act
HOCl	Hypochlorous Acid
NaCl	Sodium Chloride
NEW	Neutral Electrolyzed Water
AQUAOX	Aquaiox LLC
OCl ⁻	Hypochlorite Ion
ORP	Oxidation-Reduction Potential

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- 12.3 Reduction, Oxidation, Disinfection, Sanitation, Deodorizing and Sterilizing
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1.0 Preface

NEW[®] (Neutral Electrolyzed Water) is an all-natural, organic, non-toxic, non-irritant, environmentally and ecologically safe sanitizing and disinfecting solution. It is produced from the electrochemical reaction of water, salt and electricity. The applications for this technology are infinite and include any process requiring a sterilizing, disinfecting, cleaning or water purification facility.

NEW[®] is revolutionizing sanitization and disinfection in the food industry. Not only does this product provide a 'Green' solution to help protect the nation's food supply, it is in line with the American public's concern over escalating food product recalls and their growing demand for the industry to move quickly to implement more safe and natural products.

NEW[®] offers many advantages over traditional chemical technologies, including:

- safety
- superior disinfection performance
- removal of biofilm
- a more stable, longer-lasting chlorine residual
- enhanced micro flocculation (reduction in turbidity)
- improved taste and odor
- oxidation of iron, manganese and hydrogen sulfide

The primary component of **NEW**[®] is hypochlorous acid, the most effective element of chlorine. **NEW**[®] is pH neutral, super-oxidized water generated by electrolysis of a dilute NaCl solution passing through an electrolytic cell. This process creates large volumes of a gentle but extremely potent antimicrobial solution capable of rapid reduction of bacteria, viruses, spores, cysts, scale and biofilm. **NEW**[®] is stable, cost-effective to produce, greener than traditional chemical technologies, and can be used in multiple applications across a wide variety of industries.

NEW[®] is an oxidizing agent due to a mixture of free radicals, giving it an antimicrobial effect. Studies have shown that **NEW**[®] is highly biocidal and can substantially reduce pathogens such as *Salmonella* and *E. coli* without the use of costly toxic chemicals. In addition, it offers the added benefits of being able to remove biofilm and scale from manufacturing equipment, thus, greatly minimizing a major contributor to contamination problems.

Because **NEW**[®] effectively destroys microorganisms, they cannot build up resistance to **NEW**[®] as they can to other sanitizers and disinfectants. Standard toxic chemicals can create strains of pathogens that become resistant over time, because the cell can expel or neutralize the chemical before it can kill it, thereby causing the overall efficacy of chemical cleaners and disinfectants to be significantly reduced.

Numerous applications have been identified in agricultural, food processing and retail grocery venues where the produce, poultry, meat, seafood and dairy industries are particularly impacted. **NEW**[®] can be safely applied to food products, equipment and facilities using a variety of methods, including fogging, direct application or dosing.

The following document describes the benefits and applications of **NEW**[®], and describes the production of **NEW**[®] using the Aquaox System.

2.0 Contact Information

Aquaox LLC is a supplier of Bottled Electrolyzed Water and Systems for onsite production of Electrolyzed Water.

Aquaox LLC is located in West Palm Beach, Florida from where it serves the Americas.

Additional information on NEW[®] can be obtained by contacting the Aquaox office at +1 (561) 427-9495 at aquaox@comcast.net

3.0 NEW[®] Technology

3.1 Background

A breakthrough in chemical engineering can now generate consistently high quality, pure HOCl from unassuming food grade precursors to produce the biocidal disinfectant NEW[®]. The technology used to produce NEW[®] is based on the electrochemical activation of water (ECA technology, described below), and has been developed in line with the world trend to reduce the amount of chemicals used to purify, disinfect or sterilize water, air or any other medium. This technology was originally designed in Russia as a disinfection process, and is currently being successfully used in Europe and Canada.

Until now, HOCl has simply been thought of as a transient byproduct in the ubiquitous chlorine chemical family. However, HOCl generated by ECA technology carries with it fewer negative hydroxides than the previous HOCl formed via disassociation from sodium hypochlorite. Because of this, ECA-generated HOCl behaves uniquely and must be considered separately from chlorine. HOCl as a stand-alone chemical, separate from chlorine, has not been available in the market until now. This breakthrough results in a need for a paradigm shift in biocidal approaches. HOCl is an "old", well appreciated chemical but is now "new" in availability as NEW[®] with possibilities and applications that many consider revolutionary.

NEW[®] is manufactured through validated processes and Systems in accordance with EPA and ISO standards. Not only can NEW[®] be produced in large volume (making onsite production of NEW[®] commercially attractive), it also has an extended shelf life as a result of using a rectified AC-voltage on the patented Electrolytic Cell.

The biocidal disinfectant produced by the Aquaox System consists of 85 - 100% NEW[®].

The general product specification of NEW[®] is:

- pH 6.8 –7.8, adjustable by the operator
- Oxidation-Reduction Potential (ORP) > 800mV
- EC 5-15ppm (varies with the amount of free available chlorine)
- Free Available Chlorine (FAC) 50-500 ppm, adjustable by the operator

The active oxidizers present in NEW[®] are HOCl and hypochlorite ion, OCl⁻. The quantity of HOCl and OCl⁻ is dependent upon the pH of NEW[®].

Table 1: Composition of NEW[®]

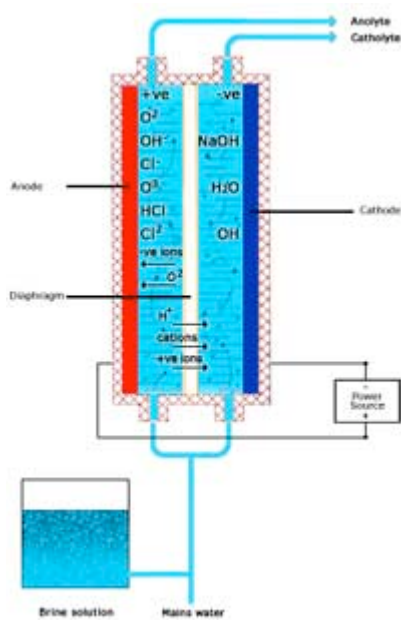
Ingredient		CAS-No	EINICS-No	Wt/Vol %	Symbols
Sodium Chloride		7647-14-5	231-598-3	<0.26%	NaCl
Free Available Chlorine (FAC)	Hypochlorous Acid (chlorine)	7790-92-3	323-323-5	<0.05% <i>Amount HOCl and OCl⁻ depending on pH</i>	HOCl
	Hypochlorite ion (sodium hypochlorite)	7681-52-9	231-668-3		OCl ⁻
Water		7732-18-5	231-791-2	>99.69	H ₂ O

3.2 Electrochemical Activation (ECA) Technology

NEW[®] is generated by electrolysis of a dilute NaCl solution passing through an electrolytic cell in the Aquaox Systems. This process is known as Electrical Chemical Activation of water, or ECA technology. ECA technology is based on Faraday's laws of electrolysis, and was developed by Russian scientists to combat biological contamination.

NEW[®] ECA Technology involves the electrolysis of molten salts. It utilizes electrolytic cells encompassing an anode chamber separated from the cathode chamber by a unidirectional ionic ceramic diaphragm (semi-porous membrane). The electrolytic cell allows migration and separation of ions through the membrane and prevention of production of gaseous chlorine (Cl₂). By passing an electrical current through the solution, an electrochemical or oxidation-reduction (redox) process occurs, generating a number of oxidized species.

Figure 1: ECA Technology



An ECA electrolysis process is one in which positive and negative electrodes are submerged in a solute containing positive and negative ions.

During this process, two separate streams of activated water are produced: Anolyte and Catholyte. Positive ions (cations) are drawn towards the electron-rich negative cathode, where they receive electrons, forming Catholyte, a negatively charged antioxidant solution. At the positive anode, negative ions (anions) are attracted, which give up their additional electrons to the electron-depleted anode to form Anolyte, a positively charged oxidant solution.

The cathode area produces alkaline (high pH) reducing water. The anode area produces acidic (low pH) oxidizing water. In the generation of NEW[®], part of the negatively charged antioxidant solution formed at the cathode is channeled back into the anode chamber to produce more anolyte, thus increasing the content of hypochlorite ions, OCl⁻, one of the active biocidal substances in NEW[®]. By reintroducing the alkaline water back into the acidic water, any

pH level up to neutral 7.0 can be created. When generated by the Aquaox System, this solution is called NEW[®]. NEW[®] is an oxidizing agent due to a mixture of free radicals present in the solution, and has an antimicrobial effect.

3.3 Mechanism of Action

NEW[®] is composed of oxidizing biocides HOCl and OCl⁻, which are general chemical oxidants. Since NEW[®] consists of both HOCl and OCl⁻ it is believed that the bactericidal action exhibited is due to the combination of these substances. They are not selective for living organisms, but react with any oxidizable matter. However, they are bactericidal because certain bacterial cell components can react readily with them, having a higher oxidation potential than most other chemicals present in water.

The bacterial cell membrane provides the osmotic barrier for the cell, and allows the active transport of substances into the cell. The bacterial membrane itself has an electrical charge. Alternations in transmembrane potential by the anions present in NEW[®] results in the rupture of the membranes and outflow of the bacterial cell contents, instantaneously destroying the cell.

NEW[®] can also disrupt other functions of the cell. Unlike “higher” organisms, single celled organisms such as bacteria obtain their energy sources from the environment immediately outside the cell. Small molecules are transported across the cell membrane via an electrochemical gradient. Thus, any significant change in the ORP of the immediate environment has drastic consequences for the cell. Even if instantaneous death of the cell does not occur, all enzymatic functions in the membrane are affected and this will also result in loss of cell viability.

The mechanism of action for the eradication of various microorganisms by NEW[®] is well documented by third party resources. The mode of action is as follows:

- The free ions in NEW[®] rapidly react and denature proteins. For this reason, NEW[®] should not be used on protein based products because it will react with and destroy the proteins.
- Once NEW[®] comes in contact with a microorganism, it attacks the bacterial proteins located in the cell membranes.
- Because of the osmolarity difference (the concentration of ions in the solution versus in the cytoplasm), NEW[®] induces the rupture of cell membranes, leading to cell lysis.

The high oxidation of NEW[®] first damages bacteria cell walls, allowing infiltration by water. The microbe reaches capacity, causing an osmotic, or hydration, overload. The acidic fluid and water floods the cell faster than the cell can expel it, literally causing the cell to burst.

NEW[®] produces a residual that continues to remain available based on bacterial demand. ORP levels can last for long periods of time depending on organic burden. Tests show that not only is NEW[®] an effective sanitizer and disinfectant, but it is also sporicidal. Sporicidal tests have demonstrated that NEW[®] treatment eliminates bacterial spores and biofilm.

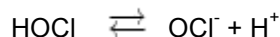
There is a push by the American public to reduce or ban antibiotic use in food-supply animal feeding rations. Antibiotics are becoming ineffective in animals and humans, and are leading to the development of antibiotic-resistant “super bugs”. The use of NEW[®] greatly reduces the need for antibiotics in animal feed rations due to the bactericidal nature of the solution. Because NEW[®] effectively destroys microorganisms, they cannot build up resistance to NEW[®] as they can to other sanitizers and disinfectants.

3.4 Chemistry

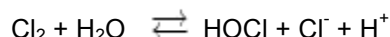
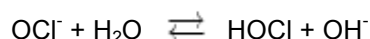
Patented ECA technology generates NEW[®] consisting of the following known chemical species:

- Hypochlorous Acid (HOCl)
- Sodium Hypochlorite (NaClO)
- Sodium Chloride (NaCl)

In aqueous solution, hypochlorous acid partially dissociates into the anion hypochlorite ClO⁻:



HOCl and OCl⁻ exist in a state of equilibrium:



The relation between HOCl and OCl⁻ is solely dependent on pH value. The pH level of NEW[®] is preferably set to ~7 to produce the highest HOCl content. HOCl and OCl⁻ are measured as FAC (Free Available Chlorine). The FAC compound is adjustable in NEW[®] from 50 to 500ppm, which is many times less than the level currently found in most biocides, but many more times potent due to the composition of NEW[®].

HOCl and OCl⁻ have been shown to be the sole active substances in the biocidal effect of NEW[®]. The quantity of HOCl and OCl⁻ formed is dependent upon the pH of NEW[®]. This is in contrast to traditional electrolysis processes, which would typically result in unstable oxidized water. Electrolysis of water may produce such products as H⁺ and OH⁻ ions, H and OH radicals, H₂, O₂, HO₂, and O₃ due to redox reactions. As a result, hydrogen and ozone gas are released and a percentage of hydroxides remain in the solution in various forms including but not limited to hydrogen peroxide.

4.0 Benefits of NEW[®]

NEW[®] is revolutionizing sanitization and disinfection in the food industry. Not only does this product provide an organic 'Green' solution to help protect the nation's food supply, it is in line with the American public's concern over escalating food product recalls and their growing demand for the industry to move quickly to implement more safe and natural products. The following benefits are realized with the use of NEW[®]:

NEW[®] is Efficient:

- NEW[®] is generated on demand and applied where required to eliminate the logistical concerns of purchasing, transporting, storing, preparing and using traditional chemical applications
- The elimination of hazardous chemicals translates into reductions in regulatory paperwork, safety training requirements, safety inspections, and liability exposure
- Eliminates the need to monitor for chlorine dioxide residuals, chlorite, or bromate
- Provides more effective cleaning ability than other toxic chemicals
- The higher biocidal capacity relative to traditional chemical solutions permits the use of lower dose rates, lessening the risk for environmental impact
- The solution is less corrosive than alternate products
- Reduces the frequency of cleaning within a facility
- Allows for the disinfection of areas where toxic chemicals are not permitted

NEW[®] is Effective:

- NEW[®] has been demonstrated to be up to 100 times more effective than sodium hypochlorite, Extensive tests have shown that the solution has the power to kill bacteria, viruses, fungi, spores and microbial toxins
- Rapidly destroys microorganisms, scale, and biofilm
- More effective than alternate sanitation chemicals
- Can be used effectively to protect against bio-terrorism
- Reduces risk mitigation
- Allows for the marketability of a “clean” facility
- Completely safe, non-harmful, green product using only natural ingredients
- More effective sanitization than Chlorine alone
- The systems are all “plug and play” and require little adjustment

NEW[®] Saves Money:

- NEW[®] is cost effective due to the fact that many more deliveries of bulk chemicals are required for the same chlorine equivalent generated by a single delivery of salt, a fact that becomes even more critical as fuel costs rise
- The capital cost of the on-site Aquaox System can often be recovered in less than a few years
- Aquaox System are depreciable assets
- A single unit produces a natural solution to supply an entire facility with numerous cost effective applications
- Eliminates the need for expensive and potentially toxic chemicals
- Reduces the costs of purchasing, transporting, storing, preparing and using traditional chemical applications
- Decreases labor requirements and costs

NEW[®] Promotes Hygiene:

As part of a HACCP plan, NEW[®] is aiding the food manufacturer in risk mitigation by helping to:

- Reduce microorganisms in foods including fish, fresh vegetables, poultry and meat
- Reduce disease risk in treated products
- Increase shelf life of treated products
- Break down bacterial biofilm in pipe systems
- Disinfect food processing areas
- Reduce the risk of consumer health concerns

NEW[®] is Convenient:

- Onsite generation allows NEW[®] to be produced on demand, 24/7
- NEW[®] can be applied as it is being produced
- The systems are mobile
- Produced and applied directly from a validated system

NEW[®] is Safe:

Safe for Products:

- Addresses public safety concerns
- All-natural, safe
- Non-toxic, non-hazardous
- No storage compatibility issues
- No residue to rinse
- No special disposal required
- Does not require a hazardous use permit

Safe for Users:

- No health and safety risks
- No protective gear required
- No eye or skin irritation
- Non-toxic (inhalation, ocular, cutaneous, ingestion)
- Non-hazardous
- No additional protective equipment required
- No exposure limits
- Lowers the risk of sickness and absence in the work place
- In its most *concentrated* form, NEW[®] could be ingested without any physical harm (though not recommended)

Safe for the Environment:

- The only elements introduced into the system are water, salt and electricity, and are all safe and environmentally friendly
- No disposal precautions
- Provides opportunity to reduce water usage
- Reduces volume of wastewater
- No adaptive resistance chance for microorganisms
- No environmental impact
- Fully biodegradable
- Satisfies the demand for implementing safer and more natural food products

4.1 Comparison of NEW[®] to Currently Used Technologies

In the early development of electrolyzed water, electrolytic cells were only capable of generating small volumes of acidic electrolyzed water with a limited shelf life. In recent years, neutral electrolyzed water (NEW[®]) has been introduced as a stable, high-level disinfectant, which is non-corrosive and able to penetrate cell membranes more easily in comparison with other currently used technologies.

NEW[®] is less toxic, less volatile, easier to handle, compatible with other water treatment chemicals, effective against biofilms and generates no by-products compared to currently used biocides. NEW[®] is highly biocidal, but has a very low chemical load (measured in FAC) as compared to sodium hypochlorite, and is thus not harmful for the environment or human beings.

Because NEW[®] effectively destroys microorganisms, they cannot build up resistance to NEW[®] as they can to other sanitizers and disinfectants. Standard toxic chemicals can create strains of pathogens that become resistant over time, because the cell can expel or neutralize the chemical before it can kill it, thereby causing the overall efficacy of chemical cleaners and disinfectants to be significantly reduced.

NEW[®] offers an environmentally sound alternative to chlorine and other oxidizing biocides. NEW[®] is proven to be more effective in killing bacteria, noroviruses, molds and other microbiological organisms than Chlorine* alone and yet remains benign enough to ingest in concentrated form. (*Hydrochloride)

NEW[®] is by chemical content nearly identical to the active components found in common chemical bactericidal agents. However, unlike the extremely toxic substances, such as chloramines, formaldehyde or iodine, the active components of NEW[®] are non-toxic, non-irritant, biologically harmless and ecologically safe. Because of its neutral pH, NEW[®] does not aggressively contribute to the corrosion of processing equipment or irritation of hands, and is more stable due to the fact that chlorine loss is significantly reduced at pH 6-9.

NEW[®] has a high Oxidation-Reduction Potential (ORP, expressed in millivolts). ORP correlates to the level of sanitizing ability of treated water irrespective of the kind of disinfectant used. For example, any water which is treated to have an ORP of >500mV for more than approximately one hour would be assured of being free of *E. coli*, *Listeria*, *Salmonella* and other pathogens. The high ORP levels of >800 mV found in NEW[®] are possible due to the elimination of caustic chemicals. This feature of NEW[®] allows for a higher level of ORP than disinfectants such as Sodium Hypochlorite (NaOCl), for example. When caustic Sodium Hypochlorite is used, it also simultaneously raises the pH of water and thereby dramatically reduces its efficacy (ORP). When NEW[®] is used, the pH of water is not raised, but is slightly lowered, and its ORP remains stable or is enhanced.

Electrochemically synthesized reagents, such as the neutral electrolyzed water of NEW[®], are gaining rapid popularity in a number of applications. Not only does this technology offer a cost-effective alternative to existing technologies, but it is also contributing to the protection of the environment. Advantages of electrochemically synthesized reagents include:

- These reagents are synthesized from diluted solutions of inorganic salts. This is in contrast to traditional chemical reagents, which are prepared by dissolving corrosive acids and alkalis
- Important parameters such as pH and oxidation-reduction potential (ORP) are manipulated by variation of the salt mixture. To achieve a similar level of manipulation for traditional chemical reagents, additional chemical compounds have to be added
- Since these reagents are manufactured on-site, transportation costs are eliminated. This is in contrast to the use of traditional chemicals, which may require timely planning, purchasing and proper storage infrastructure
- Because these reagents are produced by an environmentally safe technology, there is no need for neutralization or purification prior to use as with traditional chemical technologies

All water disinfection will result in the formation of disinfection by-products. NEW[®] is no exception, but has the advantage that it does not contain the hydroxyl ion and will oxidize organic material to form lower levels of chlorates, thus reducing halogenated by-products. The inorganic by-products, (trihalomethanes, THMs, chlorite, chlorate and chloride ions) formed when NEW[®] is used are held in balance at much lower levels. Thus, lower disinfection by-products are produced in the process, at a level of about 30% - 50% when compared with sodium hypochlorite and other oxidants.

4.1.1 Comparison of NEW[®] to Chlorine

Chlorine is currently the most widely used oxidizing biocide. It is a powerful oxidant and is used in bleaching and disinfectants.

The use of chlorine as a micro-biocide and water disinfectant is declining because of safety, environmental and community impact considerations. According to the MSDS for chlorine, this chemical is highly toxic, corrosive, and may be fatal if inhaled. It is considered to be a marine pollutant, and in the upper atmosphere, chlorine atoms have been implicated in destruction of the ozone layer. An environmentally sound alternative to chlorine and other oxidizing biocides is needed.

Various alternatives to chlorine use have been explored, including bleach, bleach with bromide, bromochlorodimethyl hydantoin (BBCDMH), non-oxidizing biocides, ozone, ultraviolet, chlorine dioxide, sodium chlorite, chloramine (chlorine & ammonia), copper-silver ionization, and thermal disinfection. Alternative Systems include chlorinators, electrically generated ozonators, and copper/silver cathodes which use electrical activity to cause the release of silver and copper ions into drinking water. Each chemical and System offers some unique advantages, but each has distinct disadvantages.

The HOCl of NEW[®] is found to have the advantages of other biocidal alternates without their disadvantages. Categories of objective analysis include: efficacy, safety, taste and odors, impact on equipment and systems, effect on scale, biofilm, residual effects, ease of use, maintenance and cost.

NEW[®] is a mixed-oxidant solution. Although it is measured and dosed as free available chlorine, it exhibits behavioral traits associated with a more active chlor-oxygen chemistry than traditional chlorine. In contrast to other chlorine technologies, mixed oxidants such as NEW[®] offer superior disinfection efficacy, elimination of biofilm, more durable chlorine residual levels, and reduced formation of disinfection by-products. Mixed oxidants readily oxidize ammonia, sulfides, iron and manganese, and can cause a micro flocculation effect (reduction in turbidity) in pretreatment. In addition, mixed oxidants offer improved taste and odor. NEW[®], even at residual levels over 12 ppm in treated water, leaves minimal to no odor or chlorine taste.

Production of NEW[®] is similar to the process of fabricating standard sodium hypochlorite (NaOCl), with one significant difference. Sodium hypochlorite combines Cl₂ with caustic soda (lye) to stabilize chlorine. The manufacture of NEW[®] eliminates the use of caustic soda by instead using high rejection membrane technology to produce pure HOCl. With the sodium removed, the benefits of HOCl become immediately evident when used as a biocide. Elimination of lye makes disinfection possible without the high pH elements associated with sodium hypochlorite. NEW[®] exists at a neutral pH (7-8), thereby delivering high efficacy in short contact times without the use of caustics. The human body pH level is approximately 7.3, therefore NEW[®] falls within the range where it is safe to the human body.

Independent research has confirmed that the effectiveness of NEW[®] on reducing total microbial counts is superior to that of sodium hypochlorite. The biocidal activity of HOCl generated by the current ECA technology is 300 times more active than the sodium hypochlorite generated by earlier systems. Sodium hypochlorite or gaseous chlorine at the same concentration as that found in NEW[®] leads to slower microbial kill and more corrosion when tested per ASTM guidelines.

Activated solutions such as NEW[®] have been conclusively shown to exceed chemically-derived equivalents both in low dosage effectiveness as well as physicochemical purity. This heightened biocidal capacity relative to traditional chemical solutions permits the use of NEW[®] at lower dose rates, decreasing the risk of adverse environmental impact.

5.0 Efficacy of NEW[®]

5.1 Biofilm

A biofilm is a complex aggregation of microorganisms, including bacteria, protozoa and algae. Biofilms are usually found on solid substrates submerged in or exposed to an aqueous solution, and given sufficient resources for growth, will quickly grow to be macroscopic. In industrial environments, biofilms can develop throughout plants and on food processing equipment, which can lead to clogging, corrosion and rampant contamination. Reductions of biofilms in industrial facilities can result in substantial thermal efficiency improvements.

Biofilms are comprised of organisms which are closely packed and firmly attached to each other and usually a solid surface. Formation of a biofilm begins with the attachment of free-floating microorganisms to a surface. If the first colonists are not immediately separated from the surface, they can anchor themselves more permanently using cell adhesion molecules such as pili. The first colonists facilitate the arrival of other cells by providing more adhesion sites and building the matrix that holds the biofilm together. Once colonization has begun, the biofilm grows through a combination of cell division and recruitment, and may continue to change in shape and size.

Bacteria living in a biofilm usually have significantly different properties from free-floating bacteria of the same species because the dense and protected environment of the film allows them to cooperate and interact in various ways. This environment allows the bacteria to develop increased resistance to detergents and antibiotics, as the dense extracellular matrix and the outer layer of cells protect the interior of the community.

Traditionally, there have been several strategies for preventing or removing biofilm, including:

- using bactericidal compounds to chemically kill bacteria
- using liquid or gas dispersants to break up the biofilm
- using mechanical means to physically remove biofilms
- using enzymes or chelants to weaken the biofilm structure

In the past, no traditional strategies have been proven to be completely effective against biofilm. Even high levels of disinfectant cannot eliminate pathogens within even small amounts of scale. Because biofilm is attached to the substrate by virtue of an electrical charge, dislodgement must be accomplished by disturbance of the charge – therefore very few chemicals are effective.

Now, researchers have been demonstrating the success of the use of electrochemically activated water as an effective alternative for removing biofilm. Results of the studies described below demonstrate the efficacy of NEW[®] on the complete removal of biofilm from surfaces and tubing.

5.1.1 Study: Biofilm Removal from Surfaces

A study was performed to research the removal of mature biofilm by application of electrochemically activated water. Figure 2a shows the mature biofilm control. Results show that exposure of the biofilm to a 1:100 dilution of electrochemically activated water did not yield any noticeable removal of the biofilm (Fig 2b); however, a 1:10 dilution and an undiluted solution resulted in the dispersion and removal of the biofilm after a 20 min exposure (Figures 2c and 2d).

Figure 2a: Mature Biofilm control

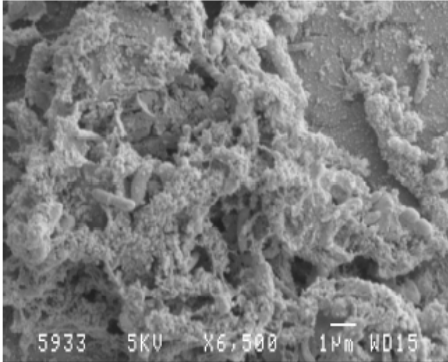


Figure 2b: 1:100 Dilution

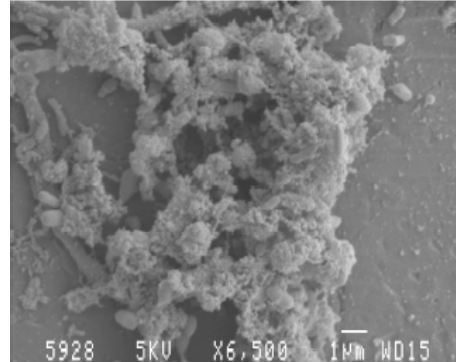


Figure 2c: 1:10 Dilution

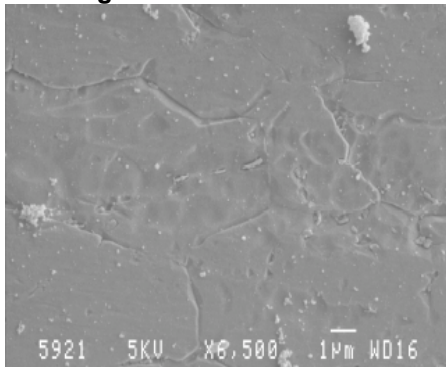
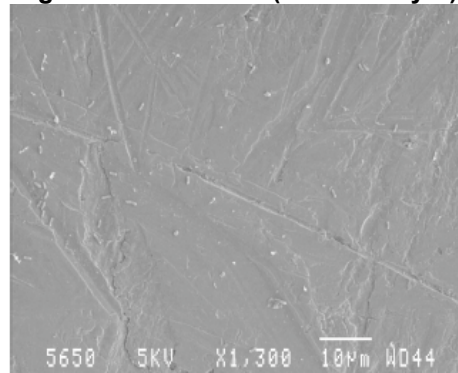


Figure 2d: Undilute (100% anolyte)



5.1.2 Study: Biofilm Removal from Tubing

A study was performed to demonstrate the removal of biofilm from 12 year old tubing from the return line of a boat. The original piece of tubing was cut in half, and each half was placed in either H₂O or freshly-generated NEW[®] (HOCl). The pieces of tubing were allowed to incubate at room temperature for one hour. Results show complete removal of biofilm for the portion of tubing soaked in NEW[®]. This proves that NEW[®] can safely and effectively be used to remove biofilm from lines in any industrial application, instead of using dangerous chemicals which may leave behind toxic residuals.

Figure 3a: Untreated Tubing



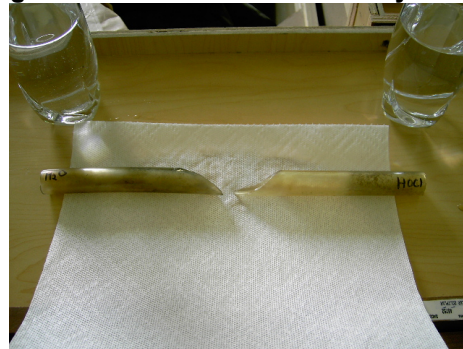
Figure 3b: Severed Untreated Tubing



Figure 3c: Incubation in H₂O or NEW[®] (HOCl)



Figure 3d: Removal of Biofilm by NEW[®]



5.2 Microorganisms

NEW[®] has a strong bactericidal effect on most known pathogenic bacteria due to its high oxidation-reduction potential (ORP > 800 mV). This non-toxic oxidized antimicrobial solution capable of killing many pathogens in less than a minute. Since NEW[®] consists of both HOCl and OCl⁻, it is believed that the bactericidal action exhibited is due to the combination of these substances. Based on various bactericidal, fungicidal and sporicidal testing performed to date, NEW[®] has proven to be a high-level disinfectant, substantially reducing pathogens without the use of costly toxic chemicals.

Destruction of most vegetative cells of bacteria, molds, and parasites is usually not difficult because they are sensitive to heat and chemicals. However, many organisms excrete extracellular polysaccharides and form biofilms that protect individual cells, and can be quite difficult to remove from surfaces and manufacturing equipment using traditional methods and chemicals. Studies have shown that NEW[®] can remove biofilm and scale from manufacturing equipment, thus greatly minimizing a major contributor to contamination problems.

Molds, *Clostridium* spp., and *Bacillus* spp. form spores that are resistant to heat, acids, and other compounds. Parasites also produce resistant cells called cysts, and virus particles are notoriously resistant to heat, chemicals, and drying. NEW[®] has been proven to be an effective sporicidal, and provides rapid reduction of spores and cysts.

Over time, microbes evolve to become resistant to some sanitizers and disinfectants. Because NEW[®] effectively destroys microorganisms, they cannot build up resistance to NEW[®] as they can to other sanitizers and disinfectants.

NEW[®] gives a much quicker inactivation rate of a wider range of microorganisms than traditional chlorination technologies, and therefore decreases the risk of waterborne diseases, outbreaks, and illnesses. NEW[®] has been successfully tested against the variety of microorganisms listed below, including several different biological weapons agents:

- *Bacillus anthracis* (anthrax)
- *Bacillus cereus*
- *Bacillus stearothermophilus*
- *Bacillus subtilis* spores
- Bacteriophage (F2)
- *Clostridium perfringens* spores
- Coliphage MS2
- *Cryptosporidium parvum* oocyst
- *Escherichia coli*
- *Francisella tularensis*
- *Giardia lamblia* cyst
- *Giardia muris* cyst
- Hepatitis A virus
- Hepatitis virus analog (F2)
- *Klebsiella terrigena*
- *Legionella pneumophila*
- *Listeria monocytogenes*
- *Pseudomonas aeruginosa*
- *Salmonella typhimurium*
- *Staphylococcus aureus*
- Vaccinia virus (smallpox)
- *Vibrio cholerae*
- *Yersinia pestis* (plague)

5.2.1 Bacterial Kill Study

A study was performed to determine the percentage of kill of different bacterial strains using different concentrations of the active component of NEW[®] produced using 3% NaCl. Bacteria were exposed to NEW[®] concentrations of Undiluted, 1:10, and 1:20. Results appear in Table 2, and showed that the NEW[®] gave 100% kill of all of the test strains at concentrations of Undiluted and 1:10. At a 1:20 dilution, variable kill percentages were observed, indicating variable susceptibility of different bacteria at dilute concentrations. In general, at the most dilute concentration (1:20), NEW[®] was more effective against gram positive organisms.

Table 2: Percentage Kill of Bacterial Strains at Different NEW[®] Concentrations

Bacterial Strain	Gram Stain	NEW [®] Concentration		
		Undiluted	1:10	1:20
<i>Bacillus subtilis</i>	+	100	100	78
<i>Pseudomonas aeruginosa</i>	-	100	100	87
<i>Acinetobacter calcoaceticus</i>	-	100	100	100
<i>Lactobacillus brevis</i>	+	100	100	100
<i>Micrococcus luteus</i>	+	100	100	100
<i>Streptococcus faecalis</i>	+	100	100	31
<i>Pseudomonas fluorescens</i>	-	100	100	66
<i>Staphylococcus aureus</i>	+	100	100	100
<i>Pseudomonas alcaligenes</i>	-	100	100	52
<i>Pseudomonas medocina</i>	-	100	100	88
<i>Pseudomonas putida</i>	-	100	100	90
<i>Bacillus cereus</i>	+	100	100	92
<i>Micrococcus roseus</i>	+	100	100	100
<i>Pseudomonas stutzeri</i>	-	100	100	57
<i>Pseudomonas syringae</i>	-	100	100	87

5.2.2 *Daphnia magna* Study

A study was performed to research the toxicity of the active component of NEW[®] on *Daphnia magna*, a water flea commonly used in toxicity studies on aquatic organisms. The study involved 21 day full life-cycle testing measuring two endpoints, mortality and reproduction. The *Daphnia* clone used was of Finnish origin from the North Savo Regional Environmental Center in Kuopio, Finland. Results of the study showed that no significant differences were found in the reproduction of *Daphnia magna* in all tested media. The mortality of *Daphnias* during testing was <10%, with only one *Daphnia* dying during the study. There were no differences observed in the size and weight at the endpoint of experiments between *Daphnia magna* grown in the test samples and in the control. It was concluded that no chronic toxicity effects were observed for *Daphnia magna* grown in the presence of the active component of NEW[®].

6.0 Stability of NEW[®]

NEW[®] has an extended shelf life and is stable for longer than one month, although it is still highly recommended to use freshly generated NEW[®]. In contrast, many other super-oxidized waters are only stable for a few hours and are produced with electrolytic cells that are very limited in production capacity as well as limited in lifetime. In these products, free available chlorine is more unstable and easily evaporates from the water, causing an immediate strong chlorine smell and complicating storage, transport and usage.

The parameters that are measured in order to establish shelf life include pH, ORP and FAC. In addition, a commonly used method to determine stability revolves around the ability of NEW[®] to kill spores of *Bacillus subtilis*, a bacterium known to be among the most resilient to chlorine. This is a useful measurement used in determining the shelf life of NEW[®], since it is ultimately this anti-microbial nature that is key to NEW[®]'s action as a high-level disinfectant.

A study was performed to compare the shelf life of NEW[®] (446 mg/L of active chlorine) to a NaClO solution (334 mg/L of active chlorine) during a 54-day period under the following storage conditions: at 4°C under artificial light, and at room temperature (23 ± 2°C) in the presence of natural light in both open and closed containers. The pH, ORP and active chlorine concentrations were periodically measured during storage. Results showed that NEW[®] exhibited better shelf life than NaClO in all of the evaluated conditions in terms of active chlorine degradation and bactericidal activity. The half-life of NEW[®] was determined to be 21 days at room temperature, and more than 54 days at 4°C.

7.0 Toxicity of NEW[®]

In data obtained from independent testing executed outside the USA by third parties, no evidence of toxicity in any form has been observed in any testing. Moreover, this claim is supported by the review of relevant literature which has revealed that HOCl and OCl⁻, at the low doses occurring in NEW[®], do not produce toxic effects. Based on this information, it can reasonably be concluded that NEW[®] is non-toxic and safe to use in the industries and applications considered by Aquaox.

8.0 Regulatory

8.1 EPA

The EPA has approved the use of NEW[®] in the raw food industry without the need for an additional processing, and has granted an "establishment number" (82060-FL-001) allowing the use of electrolyzed water that is produced on-site for the food industry.

Because speciation studies from a variety of institutions have identified only chlorine in the mixed oxidant NEW[®] solution, the U.S. Environmental Protection Agency (EPA) has determined that mixed oxidant customers need only to follow chlorine regulatory requirements, including use of chlorine CT values, limits on maximum chlorine allowed, and limits on total trihalomethane (TTHM) and haloacetic acid (HAA5) formation.

NEW[®] is approved under 21 CFR 173.315 for direct contact with processed foods, and is approved for several indirect food contact applications under 21 CFR 172.892, 21 CFR 175.105, 21 CFR 176.170 and 21 CFR 177.2800. It is an approved sanitizer that meets 21 CFR 178.1010. The EPA has also given approval (40 CFR 180.1054) for washing raw foods that are to be consumed without processing.

NEW[®] in its most concentrated form cannot be classified as hazardous in accordance with Directive 99/45/EC. Normal COSHH regulations apply. The Aquaox System does not require a hazardous use permit.

Under Section 3 of the Pesticide Regulations under the Federal Insecticide Fungicide and Rodenticide Act as amended (FIFRA), the EPA regulates pesticides which are registered and sold in interstate commerce. Under these regulations, Pesticide Systems are not required to be registered, but must have an approved label which meet the Section 3 Regulations, Part 162.10, and have a registered establishment in which they are produced. Under Section 7 of the FIFRA, each owner of a pesticide System must produce to the EPA enforcement program a report of products produced each year and to whom they are sold in a standard report form. Aquaox's System has an EPA establishment number of 82060-FL-001 and reports information pursuant to Section 7 of the Act.

Systems are subject to labeling and misbranding requirements under FIFRA section 2(p) and 2(q); registration and reporting requirements under FIFRA section 7; recording keeping requirements under FIFRA section 8; inspection requirements under FIFRA section 9; import and export restrictions under FIFRA section 17; and child resistant packaging requirements imposed pursuant to FIFRA section 25(c)(3).

The System uses electric current to produce hypochlorous ions on demand on site, which kill bacteria, mold, mildew, viruses and surface-filling algae. The System uses sodium chloride in a liquid format in water and an electric charge to generate the chlorine on demand. When the electricity has been turned off, the System produces no chlorine and contains no residual. No product is produced from the System for storage or later use per regulations.

In case of doubt or for clarification, Aquaox should be consulted. Aquaox is unable to anticipate all conditions under which the product may be used, and users are advised to carry out an assessment of workplace risk and carry out their own tests to determine safety and suitability for the process and conditions of use.

8.2 USDA

According to FSIS Directive 7120.1 of the United States Department of Agriculture Food Safety and Inspection Service, "Safe and Suitable Ingredients Used in the Production of Meat and Poultry Products", Electrolytically Generated Hypochlorous Acid has been approved in 21 CFR as a food additive for use in meat and poultry products, approved in GRAS notices and pre-market notifications, and approved in letters conveying acceptability determinations.

Table 3: Table of Safe and Suitable Ingredients
Substance: Electrolytically Generated Hypochlorous Acid

Product	Amount	Reference	Labeling Requirements
<i>Antimicrobials</i>			
Red meat carcasses down to a quarter of a carcass	Applied as a spray at a level not to exceed 50 ppm calculated as free available chlorine	Acceptability determination	None under the accepted conditions of use ⁽¹⁾
On whole or eviscerated poultry carcasses	Applied as a spray at a level not to exceed 50 ppm calculated as free available chlorine	Acceptability determination	None under the accepted conditions of use ⁽¹⁾
In water used in meat and poultry processing	Not to exceed 5 ppm calculated as free available chlorine	Acceptability determination	None under the accepted conditions of use ⁽¹⁾
Poultry chiller water	Not to exceed 50 ppm calculated as free available chlorine (measured in the incoming potable water)	Acceptability determination	None under the accepted conditions of use ⁽¹⁾
Poultry chiller red water (i.e., poultry chiller water re-circulated, usually through heat exchangers, and reused back in the chiller)	Not to exceed 5 ppm calculated as free available chlorine (measured at influent to chiller)	Acceptability determination	None under the accepted conditions of use ⁽¹⁾
Reprocessing contaminated poultry carcasses	20 ppm calculated as free available chlorine Note: Agency guidance has allowed the use of up to 50 ppm calculated as free available chlorine	9 CFR 381.91	None under the accepted conditions of use ⁽¹⁾
On giblets (e.g., livers, hearts, gizzards, and necks) and salvage parts	Not to exceed 35 ppm calculated as free available chlorine in the influent to a container for chilling	Acceptability determination	None under the accepted conditions of use ⁽¹⁾
Beef primal	20 ppm calculated as free available chlorine	Acceptability determination	None under the accepted conditions of use ⁽¹⁾

⁽¹⁾ The use of the substance(s) is consistent with FDA's labeling definition of a processing aid.

8.3 FDA

The FDA has expressed no concerns and holds no opposition for the use of NEW[®]. The use of Electrolytically Generated Hypochlorous Acid is consistent with FDA's labeling definition of a processing aid

9.0 Applications of NEW[®]

The Aquaox System uses only salt, water, and electricity to generate NEW[®], which is used onsite in its appropriate application. Physical introduction methods are described further in Section 10.0, and include the use of a dosing pump, or application directly to products, equipment or facilities via fogging, misting, spraying, soaking, immersing or rinsing. The applications for this technology are infinite and include any process requiring a sterilizing, disinfecting, cleaning or water purification facility. Potential applications are identified in the following sections.

9.1 Food Industry

Pathogenic and spoilage organisms may be present in and on foods, but only a few of these are a serious health concern because of their ability to cause human illness. The most frequent or serious causes of food borne bacterial infections include viruses, notably noroviruses and hepatitis A, parasites such as *Cryptosporidium* and *Cyclospora*, molds such as *Aspergillus spp.* and *Penicillium spp.*, and bacteria such as *Salmonella spp.*, *E. coli* O157:H7, *Clostridium botulinum*, and *Listeria monocytogenes*. Other bacteria of concern include *Bacillus cereus*, *Campylobacter jejuni*, *Clostridium perfringens*, *Shigella spp.*, *Staphylococcus aureus*, *Vibrio spp.*, and *Yersinia enterocolitica*.

Food safety is ensured largely, but not exclusively, by controlling the presence and growth of pathogenic organisms in and on foods. Numerous cleaning compounds and processes have been developed to remove and destroy bacteria, viruses, and parasites from equipment and surfaces in food processing plants and from fresh produce and animal carcasses. It is a significant challenge to maintain a clean environment in food processing plants. Antimicrobial compounds are used to eliminate or limit the growth of pathogens in foods, but these are typically costly toxic chemicals.

NEW[®] is revolutionizing sanitization and disinfection in the food industry. Not only does this product provide a 'Green' solution to help protect the nation's food supply, it is in line with the American public's concern over escalating food product recalls and their growing demand for the industry to move quickly to implement more safe and natural products.

Independent studies have discovered the following benefits of mixed oxidants such as NEW[®] when used in food processing:

- Very effective control of target bacteria, even at elevated pH values
- Equally effective in direct contact or clean in place (CIP) applications

NEW[®] is non-toxic, inexpensive to produce, and can be used in multiple applications due to its various inherent sanitizing characteristics. Food retailers can use it to wash incoming products, sanitize equipment, prevent cross-contamination, and clean their facilities. It can be used in food storage facilities in fogging systems to kill airborne pathogens, or in sanitized ice. Food processors can use it for cleansing processing equipment, eliminating biofilm from piping systems, and disinfecting surfaces and facilities. Food preparation facilities can use NEW[®] to sanitize equipment and food prep areas to reduce the possibility of causing or spreading food borne illness.

9.2 Organic Markets / Foods

NEW[®] is all-natural, organic, non-toxic, non-irritant, environmentally and ecologically safe. This product provides a 'Green' solution to help the food industry to implement more safe and natural products.

NEW[®] can be applied using sprayers to sanitize organic produce. It can be fogged into greenhouses, or sprayed to kill microbes on plants. NEW[®] can be dosed into water or irrigation systems to kill bacteria and reduce biofilm, without the use of dangerous toxic chemicals.

9.3 Dairy Industry

9.3.1 CIP Cleaning of Pipeline Milking System

Most US farms use some form of mechanized system to milk cows. The system usually involves a rubber-lined suction cup that milks the cow, and a series of pipes that transfers the milk to a central refrigerating tank. At the end of the day, the whole system undergoes a four-step CIP process. The pipes are first rinsed with warm water to remove the milk, and are then flushed with a chlorinated detergent at a high temperature to remove soils such as fat and protein deposits. A weak acid is used to neutralize the detergent and remove mineral deposits, then the pipes are sanitized with an approved sanitizing agent.

Studies have been performed by Penn State researchers to investigate the use of NEW[®] as a replacement for the chemicals used to clean and disinfect milking equipment. The researchers flushed warm raw milk laden with typical dairy bacteria down a series of pipes set up to mimic the system on a farm, then compared the cleaning and disinfecting power of NEW[®] to conventional treatments. The results showed that in 7.5 -10 minutes, NEW[®] was as effective in removing organic matter from the pipes as conventional treatments, with the added benefit of not adding toxic chemicals to the process, and ultimately the product.

9.4 Poultry Industry

9.4.1 Care of Chickens

Many applications have been identified for NEW[®] in poultry house sanitization. The use of NEW[®] can result in:

- enhanced fodder assimilation
- improved weight gain
- increased vitality
- decreased mortality rates
- decreased incidence of avian influenza
- improved pest control on feathers (lice)
- reduced need for antibiotics
- suppressed disease transfer by spraying or soaking fecal piles

This proven technology is already being successfully used in Europe and Canada, and is helping to protect the health of chickens by dosing their drinking water to remove biofilm and kill bacteria, misting or fogging the airspace in their living quarters, cleaning tools and equipment, and sanitizing the surfaces of living spaces (floors, walls).

There is a push by the American public to reduce or ban antibiotic use in feed rations. Antibiotics are becoming ineffective in animals and humans, and are leading to the development of antibiotic-resistant "super bugs". The use of NEW[®] greatly reduces the need for antibiotics in animal feed rations due to the bactericidal nature of the solution. Because NEW[®] effectively destroys microorganisms, they cannot build up resistance to NEW[®] as they can to other sanitizers and disinfectants.

9.4.2 Egg Production

In the egg processing facility, NEW[®] can effectively be used to sanitize surfaces, egg grading and packing equipment, as well as the eggs themselves. Eggs can be sprayed with NEW[®] to disinfect their surfaces, effectively decreasing the risk of a potential food borne outbreaks without adding costly toxic chemicals to the semi-permeable surface of the egg.

In the University of Georgia's poultry department, the use of NEW[®] has been shown to have an impact on populations of pathogenic bacteria including *Salmonella typhimurium*, *Staphylococcus aureus*, and *Listeria monocytogenes*, all of which are common fresh egg contaminants. NEW[®] was determined to be effective when used in conjunction with electrostatic spraying for the elimination of pathogenic populations of bacteria from egg surfaces, in many cases completely eliminating the pathogens.

During commercial processing, eggs are washed in an alkaline detergent and then rinsed with chlorine to reduce dirt, debris, and microorganism levels. A study was performed to determine the efficacy of NEW[®] to decontaminate *Salmonella enteritidis* and *Escherichia coli K12* on artificially inoculated eggshells during this commercial egg washing process. Eggs were soaked in NEW[®] at various temperatures and times. Treated eggs showed a reduction in population between ≥ 0.6 to $\geq 2.6 \log_{10}$ cfu/g of shell for *S. enteritidis*, and ≥ 0.9 and $\geq 2.6 \log_{10}$ for *E. coli K12*. \log_{10} reductions of 1.7 and 2.0 for *S. enteritidis* and *E. coli K12*, respectively, were observed for typical commercial detergent-sanitizer treatments, whereas \log_{10} reductions of ≥ 2.1 and ≥ 2.3 for *S. enteritidis* and *E. coli K12*, respectively, were achieved using the NEW[®] treatment. For the pilot-scale study, NEW[®] was compared with the detergent-sanitizer treatment using *E. coli K12*. \log_{10} reductions of ≥ 2.98 and ≥ 2.91 were found using the NEW[®] water treatment and the detergent-sanitizer treatment, respectively. The effects of 2 treatments on egg quality were investigated. NEW[®] and the detergent-sanitizer treatments did not significantly affect albumen height or eggshell strength. These results indicate that NEW[®] has the potential to be used as a sanitizing agent for the egg washing process.

Research was conducted to compare the effectiveness of NEW[®] applied using an electrostatic spraying system for killing populations of bacteria that are of concern to the poultry industry. Populations of pathogenic bacteria (*Salmonella typhimurium*, *Staphylococcus aureus*, and *Listeria monocytogenes*), and the indicator bacterium *Escherichia coli* were applied to eggs and allowed to attach for 1 hour.

Results showed that:

- NEW[®] completely eliminated all *Salmonella typhimurium* on 3, 7, 1, and 8 out of 15 eggs in Repetitions (Rep) 1, 2, 3, and 4, respectively, even when very high inoculations were used
- NEW[®] completely eliminated all *Staphylococcus aureus* on 12, 11, 12, and 11 out of 15 eggs in Rep 1, 2, 3, and 4, respectively
- NEW[®] completely eliminated all *Listeria monocytogenes* on 8, 13, 12, and 14 out of 15 eggs in Reps 1, 2, 3, and 4, respectively
- NEW[®] completely eliminated all *Escherichia coli* on 9, 11, 15, and 11 out of 15 eggs in Reps 1, 2, 3, and 4, respectively

Even when very high concentrations of bacteria were inoculated onto eggs (many times higher than would be encountered in industrial situations), NEW[®] was found to be effective when used in conjunction with electrostatic spraying for eliminating pathogenic and indicator populations of bacteria from hatching eggs.

9.5 Meat Industry - Beef, Pork, and Lamb

9.5.1 Care of Livestock

NEW[®] has applications in barn sanitization, helping to protect the health of the livestock such as cattle, pigs and sheep.

The use of NEW[®] can result in:

- increased vitality and immune function
- improved fertility
- better feedstuff utilization
- reduced tension and stress
- decreased mortality rate
- improved weight gain
- enhanced growth and better yield
- reduced need for antibiotics
- suppressed disease transfer by spraying or soaking manure piles

Already being successfully used in Europe and Canada, this proven technology is helping to protect the health of livestock by dosing their drinking water to remove biofilm and kill bacteria, fogging the airspace of the barn, cleaning tools and equipment, and sanitizing the surfaces of living spaces (floors, walls) of the animals.

Because of its effectiveness against a wide variety of bacteria, NEW[®] may be used for the residue-free prevention and treatment of such illnesses as:

Cattle

- clinical and sub clinical mastitis
- udder edema
- teat cuts and abrasions,
- metritis
- diarrhea
- trichomoniasis
- calf scours
- calf pneumonia.

Pigs

- scours
- mastitis
- *Streptococcus agalactia*
- diarrhea

The push by the American public to reduce or ban antibiotic use in feed rations also extends to the livestock industry. The development of antibiotic-resistant “super bugs” is causing antibiotics to become ineffective in animals and humans. The use of NEW[®] greatly reduces the need for antibiotics in animal feed rations due to the bactericidal nature of the solution. Because NEW[®] effectively destroys microorganisms, they cannot build up resistance to NEW[®] as they can to other sanitizers and disinfectants.

9.5.2 Slaughtering

NEW[®] can be used throughout a slaughtering facility to disinfect equipment, lines, and food contact surfaces. This non-toxic solution can be safely applied directly to freshly slaughtered meat to pre-disinfect carcasses to reduce microbial load and decrease the amount of new growth.

9.6 Fish / Seafood Industry

The fish and seafood industry is especially vulnerable to serious illness because the products are often consumed in a raw or partially-cooked state. In particular, shellfish is often contaminated with pathogens from raw sewage or naturally-occurring microbes such as *Vibrio vulnificus* or *V. parahaemolyticus*, both of which can cause serious illness or death. Because molluscan shellfish filter and concentrate pathogens from the surrounding water in their tissues, this is especially dangerous if they are consumed with no processing to inactivate microbial pathogens.

NEW[®] solutions can be used to address the risk of food borne illness outbreaks in the fish and seafood industry. The product can be treated upon harvest or processing to reduce the microbial load, then stored on sanitized ice produced from water which has been dosed with NEW[®] to further suppress microbial populations. The result is a product which has been treated with a non-toxic solution to give it increased shelf life with no change in flavor or quality.

9.7 Produce Industry

The use of NEW[®] has numerous applications in the produce industry, and can be used for disinfecting products along the entire food chain process for fruits and vegetables. It is effective in killing food-borne pathogens and reducing microbial counts in vegetables and fruits, resulting in prolonged shelf-life of these products. This topic is especially important to the American consumer given the recent outbreaks of *E. coli* in fresh spinach products in the U.S.

NEW[®] can be sprayed, fogged, or directly applied to produce without affecting taste or quality. It can be dosed through grocery store misters to reduce microbial counts, or frozen into sanitized ice for keeping produce cold and preventing cross-contamination.

Many studies have been performed on NEW[®] to determine its effectiveness for reducing bacteria in produce. All findings suggest that NEW[®] could be useful in controlling pathogenic microorganisms on fresh produce.

- NEW[®] was shown to have decontaminative effects on the surfaces of lettuce by significantly reducing the aerobic bacteria, coli form bacteria, molds, and yeasts. It has also been tested and shown that NEW[®] has no impact on the sensory quality of lettuce, which included taste, smell, and texture. NEW[®] has also been shown to effectively inactivate *E. coli* O157:H7, *Salmonella enteritidis* and *Listeria monocytogenes* on lettuce
- A study done on alfalfa seeds and sprouts determined that the use of NEW[®] on these products yielded a reduced growth of *Salmonella* as compared to the control
- A study was performed to determine the efficacy of NEW[®] on tomatoes that were spot inoculated with *E. coli* O157:H7, *Salmonella enteritidis*, non-pathogenic *E. coli*, and *Listeria monocytogenes*. Results showed a significant log reduction in numbers bacteria after treatment with NEW[®], without affecting the organoleptic characteristics of tomatoes
- A study was performed to determine the effectiveness of NEW[®] for inactivating *E. coli* O157:H7. Apples were inoculated with *E. coli* O157:H7, treated with NEW[®] for 5 minutes or 10 minutes at 10°C and 26°C, and were stored for up to 6 weeks at 5°C. Results showed that the apples treated with NEW[®] achieved an average log reduction in the range of 3.7 to 4.6 cfu/apple, without affecting the quality of the apples
- A study was performed to determine the effect of NEW[®] on the bacterial counts of fresh-cut spinach leaves. Results showed that NEW[®] demonstrated the same effectiveness as treatment with sodium hypochlorite solution, without the potential problems experienced when using sodium hypochlorite - high concentration of available chlorine and sodium residue

9.8 Agriculture and Horticulture Industries

NEW[®] has many agricultural and horticulture benefits, including:

- increasing crop yield
- disinfecting grain, seeds and bulbs
- prolonging the shelf life of cut flowers
- purifying irrigation water
- accelerating the growth of plants
- increasing the number and yield of flowers

Studies have been conducted to determine the effect of using NEW[®] to disinfect seeds prior to planting. Results show that NEW[®] suppresses fungal and bacterial growth on seeds, resulting in significant reductions in microbial populations within several minutes of exposure without affecting seed germination. Spraying of NEW[®] on fruit tree and vegetable foliage has resulted in reduced incidence of disease and equal or increased yield, without the use of costly toxic chemicals. NEW[®] has also been useful in removing biofilm and pathogens from irrigation equipment. There is evidence that sprayed NEW[®] enriches plants with CO₂, stimulating photosynthesis and resulting in increased yields.

9.9 Beverage Industry

Numerous NEW[®] applications have been identified in the cleaning and sanitizing of the bottling and brewing facilities and equipment. NEW[®] can be used to sanitize bottles without the use of toxic chemicals on product contact surfaces.

Chemical use in the brewing industry includes:

- Cleansing and disinfecting of bottles
- Disinfecting of main water source used for beer production
- Cleansing and disinfecting of tubes, containers and tanks
- Removal of biofilms in tubes and disinfecting pipes after use

A study was performed to test the bactericidal and sporicidal activity of NEW[®] against “beer-specific” bacteria and spores *Lactobacillus frigidus*, *Pediscoccus damnosus*, *Sachh. diastaticus* and *Pichia anomala* to evaluate this technology as a replacement for existing chlorine or chlorine dioxide chemicals. Stainless steel conical beverage industry containers were filled with 100L of tap water at room temperature. Test bacteria with or without 0.3% organic load were added to the tap water and were well mixed for 3 minutes. A sample of the initial solution was taken and isolated. A known amount of NEW[®] was added to the contaminated tap water and was well mixed for 3 minutes. Samples of the treated tap water were taken 5, 10, 15 and 20 minutes after mixing. Results showed rapid reduction of all test organisms, with or without the presence of dirty organic load conditions.

9.10 Military Applications

NEW[®] has been found effective in military applications as a solution for non-toxic decontamination. NEW[®] can be used to combat bioterrorism by:

- dosing government facility water supplies
- fogging facilities to kill airborne pathogens
- purifying troop water supplies
- assisting in biological cleanup
- providing a means for personal decontamination

9.11 Water Treatment Facilities

NEW[®] has been proven effective in the treatment of both potable and wastewater systems. Its biocidal capabilities can be applied anywhere water is used or processed by dosing it directly into the system, without causing a strong chlorine taste or smell. Treated water can also eliminate or reduce pathogens from surfaces it contacts. Hand washing at sinks supplying treated water, for example, will result in greater eradication of bacteria on the hands and, subsequently, fewer cases of cross contamination and nosocomial infection. Similarly, equipment (ice machines, dental unit water systems, beverage dispensers, endoscopes, countertops, etc.) in contact with treated water will be cleared or reduced of pathogens and be kept free of mineralization and biofilm.

Water and water distribution systems in facilities (hospitals, hotels, dental clinics, nursing homes, prisons, industrial plants, agricultural/food processing plants, schools, restaurants, and homes, etc.), and equipment (such as cooling towers, evaporative coolers, misters, etc.) are all subject to microbial contamination. Various studies and incidents of infection have revealed waterborne pathogens including *Staphylococcus*, *Streptococcus*, *E. coli*, *Cryptosporidium*, *Giardia Lamblia*, *Listeria* and *Legionella*, the bacterium that causes Legionnaires' disease. Contamination may come from two basic sources: contamination in water received from the source and contamination from reverse migration.

It is understood by the EPA and the municipalities, and generally misunderstood by the general public, that even a well-operated water treatment system cannot ensure that drinking water will be completely free of parasites, bacteria, and other contaminants. Microbial water analyses reflect only loose bacteria present and not those trapped in biofilm, nor viral particles. Municipal water treatment agencies are required to reduce or test for a multitude of microorganisms, disinfectants, disinfectant by-products, inorganic and organic chemicals, and radionuclides. Although municipalities provide water of high standards, they are not required to, nor do they claim to eliminate contaminants entirely. For example, only requiring 99% elimination of *Cryptosporidium*, the EPA quantifies the expected number of illnesses from the 1% allowable to be 463,000 cases annually. In 1993, Milwaukee experienced a major outbreak of *Cryptosporidium* where approximately 400,000 people were affected, more than 4000 were hospitalized and nearly 100 people died. Municipalities are not required to control or even test for *Legionnaires' disease* but surveys of hospitals' water systems have shown that up to 70% are colonized with *Legionella*. It has been found that 2% to 15% of mortalities from nosocomial cases of pneumonia in hospitals are from *Legionnaires' disease*. OSHA estimates that over 25,000 cases of *Legionnaire's disease* occur each year and cause more than 4,000 deaths.

Another source of water, underground wells, is not regulated at all by the EPA. Well water comes in various levels of quality, none of which comes with any disinfection to treat possible contaminants.

Reverse migration of bacteria is another source of contamination within water distribution systems. American Dental Association studies show that contamination begins at the discharge point of water appliances and migrates back to the source of the water. Microbial populations increase rapidly, migrating up inside the water line, even when using sterile water, flushing the line between uses and flushing the system with bleach once a week. Sinks, faucets, showerheads and many other types of water equipment in any kind of facility are constantly being exposed to various human and environmental contaminants. These contaminants are pronounced in high use settings like hotels, hospitals, restaurants and other areas used by numerous people who may be in various stages of transmitting infectious bacteria.

Whether its source is from municipality or well supplied water, or from reverse migration, bacteria survive and grow within cold and hot water distribution systems partly because the chlorine residual levels of municipal water treatment (between .5 - 1.5 ppm) are not sufficient to destroy all contaminants. In fact, one study showed that in a relatively new hospital where sodium hypochlorite was being added to consistently maintain the available chlorine level at approximately 1.5 ppm, tests revealed that more than half of the samples taken in patient room faucets contained bacterial colony forming units too numerous to count. If the chlorine residuals were to be raised to the level required for microbial elimination (2 - 6 ppm), the taste and safety of the water would be unacceptable. Even then, sodium hypochlorite would not eliminate scale and therefore the pathogens and spores harbored in the scale would remain and recontaminate the system.

The contamination dilemma is applicable to many industries. The health care industry, for example, knows that waterborne pathogens are in their systems, and they know attacking the problem at its root is typically the best and most cost effective approach. Many hospital administrators feel that nosocomial (facility acquired) incidents of Legionnaires' disease, although causing 2-15% of the nosocomial cases of pneumonia, is less of a concern than other more prevalent bacteria, such as *Staphylococcus*, which causes an estimated 500,000 nosocomial infections and 88,000 deaths annually. Six percent (6%), (over 2 million) of all patients admitted to US hospitals contract a nosocomial infection. A significant portion of these are from waterborne contaminants. Hospitals, healthcare facilities, food processing and other industrial facilities are required to adhere to guidelines (OSHA, JCAHO, CDC, FDA, etc.) to attack and treat the sources of contamination. Individual facility engineers are faced with a potentially catastrophic public health problem.

9.12 Health Care Industries

Due to its biocidal properties, NEW[®] is being used in many healthcare settings, including dental offices, doctor offices, and hospitals. The following applications have been identified:

- Cold sterilization of medical instruments
- Surface cleaning
- Production of sanitized water and ice
- Disinfecting linens
- Air disinfection
- Room cleaning
- Cleaning of equipment
- Wound treatment

9.13 Travel Industry

The use of NEW[®] has many potential applications in the travel industry to protect travelers and prevent the spread of disease to new areas. NEW[®] can be used in airplanes, cruise ships and hotel rooms by fogging it into the air, circulating it through air ducts, applying it directly to surfaces, and dosing it into the water system. Passengers could be “misted” as they enter and leave new areas. NEW[®] helps prevent potential outbreaks of illness from pathogens such as norovirus.

9.14 Household Uses

Many applications have been identified for NEW[®] at home. It can be dosed into any appliance having a water connection, including icemakers, dishwashers, and refrigerators. NEW[®] is already being used to sanitize swimming pools, spas, and hot tubs, and it shows great efficacy in home cleaning applications due to its antimicrobial activity.

A study was performed to evaluate the efficacy of NEW[®] to reduce populations of *E. coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, and *Listeria monocytogenes* on plastic and wooden kitchen cutting boards as compared to NaOCl. Results showed that NEW[®] was equally effective to NaClO, with the added advantages of being non-toxic and having increased shelf life.

10.0 Introduction Methods

NEW[®] can be safely applied to food products, air, water, equipment and facilities. A variety of methods can be used to apply NEW[®] in concentrated or diluted form. Upon production by the Aquaox System, NEW[®] is collected into a storage container, from which it can be applied using methods such as dosing by means of a dosing pump, or applied to products, equipment or facilities via fogging, misting, spraying, soaking, immersing or rinsing. Items may be soaked or immersed in NEW[®] for disinfection.

Fogging

Fog is a cloud in contact with the ground. Artificial fog is generated by means of aerosols or is created by vaporizing water. Fogging kills airborne bacteria, viruses and microbiological organisms. Fogging of NEW[®] will not cause the floor to get wet.

Electrostatic Fogging

Electrostatic fogging occurs when a negatively charged solution is introduced into the air which seeks out positively charged surfaces, causing larger areas to be treated more effectively.

Freezing

NEW[®] can be dosed into ice machines creating sanitized ice, which has many applications in the food industry, including the storage and display of fish and shellfish.

Dosing

Dosing involves the introduction of NEW[®] into a process fluid, atmosphere or to another media in intervals to give it sufficient time to react or show results.

Misting

A mist is a phenomenon of a liquid in small droplets floating through air. Misting is executed with the help of aerosols. Generally, misting NEW[®] causes the floor to get wet.

Humidifying

A forced air humidifying system introduces NEW[®] into the air to sanitize a confined space such as an office building, cruise ship or airplane.

Spraying

Spraying involves disinfecting a surface by applying NEW[®] using a spray gun or high pressure cleaner. Spraying allows NEW[®] sufficient contact time with the surface for disinfection.

Soaking

Soaking involves placing a subject in a bath and allowing the subject to become saturated or permeated with NEW[®].

Rinsing

Rinsing is accomplished by washing lightly, as by pouring NEW[®] into or over a subject.

Immersing

Immersing in a bath involves plunging a subject into or placing it under a liquid, also known as dipping or sinking.

11.0 Manufacturing Equipment for NEW[®]

Aquaox Systems are designed to produce NEW[®] onsite for use in a multitude of different applications where there is a need for disinfection and sterilization. The generation of NEW[®] is accomplished through the use of Aquaox's mobile water system treatment Systems to produce safe, fast-acting disinfecting and sterilizing liquids onsite:

All Systems consist of 2 enclosures to keep electricity and water separated. The electrical enclosure contains all printed circuit boards, power supply and all other electrical components needed to create a rectified AC-voltage. The hydraulic enclosure contains the electrolytic cell, an eductor, a solenoid valve and manual valves to adjust the volume and properties of the product. The equipment is set up by the factory to generate biocidal liquids consisting of 85 - 100% NEW[®] with a pH between 6.8-8.8, an ORP over 800mV, and 50-500 ppm FAC (Free Available Chlorine). Aquaox Systems operate automatically, and ensure that the storage container is filled at all times with NEW[®].

Figure 4: Aquaox System



Figure 5: Electrode for the Aquaox System



Aquaox Systems utilize an electrolytic cell to electrochemically activate a brine solution (NaCl). Within the cell are two chambers (anode chamber and cathode chamber) separated by a diaphragm. Each chamber consists of an electrode. The anode chamber has a positive electrode and the cathode chamber has a negative electrode. A DC current is connected to the cell.

A brine solution passes through the cathode and anode chamber and is activated by electrolysis, resulting in a biocidal liquid, NEW[®]. The strength of the NEW[®] varies with the current flowing between the electrodes and gives different values for ORP (redox-potential), pH and Cac (active chlorine).

NEW[®] is collected into a storage container, from which it can be dosed by means of a dosing pump, or applied to products, equipment or facilities via fogging, misting, spraying, soaking, immersing or rinsing.

11.1 Features

Aquaox Systems offer the following features:

- Stand alone or in production process
- Self-cleaning cycle, which ensures low maintenance and maximum productivity
- Unique design of the Electrolytic Cell ensures the most effective use of energy and minimum waste of raw materials, and allows the brine solution to have maximum contact with the electrodes
- Minimal hydraulic resistance against liquids provides optimal flow rate
- Specifically designed electrodes and diaphragm
- Tubes and connectors are made of medical/food approved plastics and are highly resistant against aggressive solutions
- Electrodes and diaphragm are specifically designed to endure high electrochemical loading
- Enclosures are made of non-corrosive materials
- Level-switches enable to start and stop the unit automatically
- All components are produced in the United States and are supplied under manufacturer's warranty: No leakage up to 45 psi, no leaching of heavy metals into the disinfecting liquid, and an extreme long lifetime of the electrodes and membrane is guaranteed

The patented electrolytic cells offer the following features:

- Cells are leak-free up to 45psi
- Long lifetime and long production time
- Large volume (50L/h, 100 L/h, 200 L/h and 400 L/h)
- Superior performance in terms of generated Free Available Chlorine, ORP and conductivity
- Ceramic membrane and coating of electrodes can be easily inspected
- Cells can be refurbished yearly prolonging the lifetime of the cell
- Electrodes can be reconditioned up to 5 times
- Ceramic is made of very robust material and is not 'brittle' as is typical of ordinary ceramic
- All material used is chlorine resistant and approved for medical usage in drinking water applications. (Both electrodes are made of titanium grade 2; end-caps are made of Kynar/Nylon/PVC/HMWPE; fittings are made of Kynar/Nylon; rods, washers and bolts are made of stainless steel 316i)
- Cells can be manufactured and supplied in mass
- Cells are supplied from stock ensuring immediate delivery
- Cells are EPA-approved

11.2 Patents

All Aquaox Systems make use of patent-pending cells.

11.3 Guarantee

The expected lifetime of the patented cells used in Aquaox Systems varies between 3 - 5 years or between 26,280 - 43,800 working hours. Aquaox cells are guaranteed for 1 year or not less than 12,000 working hours.

11.4 Warranty

Aquaox will replace cells free of charge within the 1st year or not less than 12,000 working hours, provided that the Aquaox System was maintained and serviced according to Aquaox instructions. Cells older than 1 year or more than 12,000 working hours will be replaced only if a defect is obvious as a result of faulty assembling/manufacturing of the cell.

11.5 Specifications

11.5.1 Capacities

Aquaox Systems vary in hourly production capacity of NEW[®] between 50 - 400L/hr, depending on the type and the number of cells implemented in an Aquaox System.

11.5.2 Dimensions

Size and weight of Aquaox Systems may vary depending on capacity.

11.5.3 CE quality approval

Aquaox Systems are manufactured conform to the Low Voltage Electrical Equipment and Electrical Safety Regulations and is designed to comply with the requirements of the following EEC Directives:

- Low Voltage Directive and Electrical Safety Requirements (EN60950)
- E.M.C Emissions Testing (EN55022)
- E.M.C Generic Immunity Testing (EN 50082-1)
- CE Marking LVD Directive (93/68/EEC)
- Electro Magnetic Compatibility Directive (89/336/EEC)
- European Low Voltage Directive (73/23/EEC)
- European Machinery Directive (98/37/EEC)

11.6 Operating Requirements

11.6.1 Water

The main water connection to the Aquaox System meets the directive for "Quality on water intended for human consumption". All incoming water is softened by means of an ion-exchange resin, and the water pressure of all incoming water is reduced to 2-2.5 Bars. The sodium chloride used for regeneration of the ion-exchanger conforms to EN 938:2000. A common drain must be available to drain liquids in case of emergency or maintenance, and should be a maximum of 1.5 meters from the System and preferably at floor height.

11.6.2 Power Supply

Aquaox Systems are equipped with a flexible cord plug conform to the Low Voltage Electrical Equipment and Electrical Safety Regulations [EN 60950]. For Aquaox Systems with a capacity of up to 100 L/hr, 120-240V AC \pm 10% and a 16/32amp fused socket are required. For Aquaox Systems with a capacity >200 L/hr, 120-240V AC \pm 10% and a 32amp fused socket are required.

11.6.3 Ventilation

In each electrochemical generating process, hydrogen is produced at the cathode chamber as a by-product. Hydrogen is not soluble in water and therefore hydrogen bubbles are transported with the by-product (Alkaline Water) into the drain. Hydrogen is lighter than oxygen and will evaporate from the liquid. In low levels, hydrogen is harmless, but it becomes flammable and explosive if hydrogen exceeds 4 L per 1000 L oxygen.

Using Faraday's law, the maximum possible volume of hydrogen that could potentially be produced in the largest volume Aquaox Systems is 108 L/hr. Based on this maximal level of 108 L/hr hydrogen, the requirements for the minimal volume of air in the production room are calculated to be 8.1m³. Mechanical ventilation is required when the minimal volume air is less than 8.1m³, and is calculated to be 120m³/hour. Mechanical ventilation is also required when the volume of air exceeds 8.1m³ but natural ventilation is not sufficient to refresh the total volume of air in one hour. A room has sufficient natural ventilation when the total of all useful ventilation canals is at least 0.5% of the total floor space. The useful ventilation surface of all canals and holes cannot be smaller than 2dm².

11.7 Operating Principle and Installation

Aquaox Systems operate automatically, and ensure that the storage container is filled at all times with NEW[®].

The working current can vary with the dosing of brine solution. The level of working current on the cells indicates the amount of active chlorine generated in the NEW[®]. Decreasing or increasing the volume of brine solution alters the current. The working current is kept constant by controlling the dosing of brine solution. The internal processor measures the current and gives impulses to the brine pump to dose more or less brine solution into the incoming water.

The amount of brine consumption is proportional to the amount of active chlorine produced. This ratio is called NaCl conversion. NaCl conversion may vary slightly from installation to installation, but is constant for each Aquaox System.

It is important that pH, ORP and active chlorine are kept consistent during the production of NEW[®]. These can be stabilized by regulating the parameters listed below, which are described in the following section:

- Water hardness
- Water pressure
- Water volume
- Brine solution
- Voltage on the cells
- Current on the cells

11.7.1 Water Hardness

Water hardness affects the electrochemical generating process because CaCO_3 causes scaling of the electrode and diaphragm in the cathode chamber. Scaling is notable when more brine-solution is needed to maintain the working current.

11.7.2 Water Pressure

Aquaox System require a stable water pressure between 1.0 - 2.0 bars. In situations where water pressure is fluctuating, a pressure booster pump is installed. If water pressure is above 2.0 - 2.5 bars, a pressure reducer is installed.

11.7.3 Water volume

A volume flow meter is installed on Aquaox Systems to regulate the water flow to the required volume, and to provide a visible way to monitor the water flow.

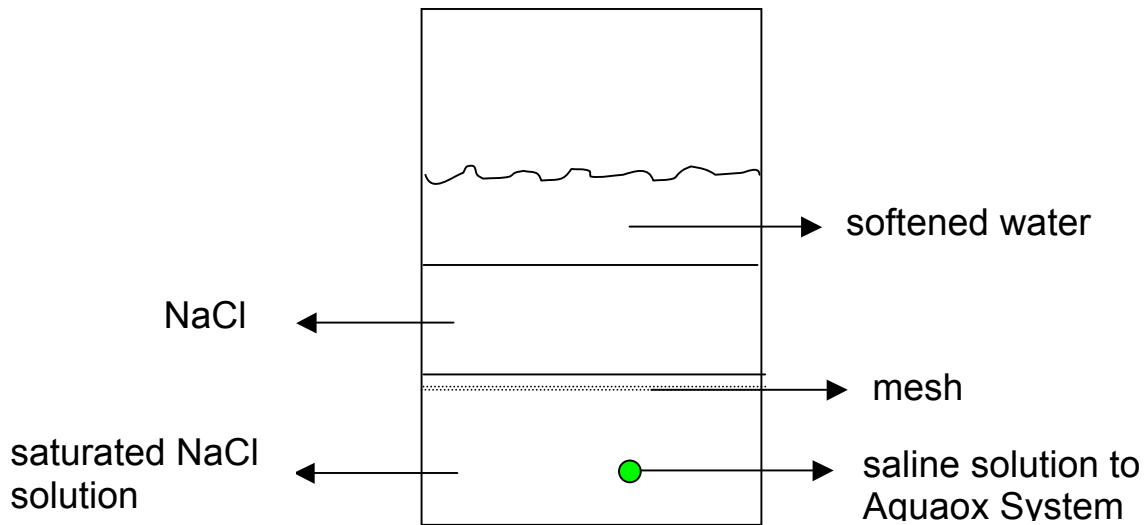
11.7.4 Brine solution

Aquaox Systems use NaCl to produce NEW[®]. In order to guarantee the consistent high quality of the NEW[®] produced, only NaCl with the highest purity should be used, and should conform to EN 973:2000 'Sodium Chloride for Regeneration of Ion-Exchangers'. Provided that water hardness, pressure, flow, quality of brine solution, and voltage are constant, the brine consumption of the generator remains stable.

A special brine container on the Aquaox System enables the generation of brine solution. In the container, a thick layer (>25cm) of NaCl is placed on a layer of permeable mesh, which holds the NaCl approximately 10-15cm above the bottom of the container. The container is automatically filled with softened, pressure- and volume-controlled water by means of a hydraulic valve. The water passes through the mesh, and as it passes the salt layer, it becomes fully saturated with NaCl, generating a brine solution which is pulled below the mesh at bottom of the container.

Figure 6: Brine Container Used on the Aquaox System

Brine container



11.7.5 Voltage on Cells

The cells in Aquaox Systems require a stable working voltage between 28-32 volts DC on each cell, depending on the capacity of the cell. The exact required voltage is specified in the equipment manual.

11.7.6 Current on Cells

The constant working current required for each Aquaox System may vary, as different capacity cells need different current. The exact required working current is specified in the equipment manual.

11.8 Operating Procedure

11.8.1 Automatic start/stop

Aquaox Systems automatically start the production of NEW[®] when the level switches in the storage container indicate that the container is getting empty. When the storage container is full, level switches stop production of NEW[®].

When the Aquaox System starts producing NEW[®], it opens the input valve, allowing incoming softened, pressure- and volume-controlled water to pass to the cell. Then, the voltage on the cell is turned on and the brine pump is activated. Within seconds, the current rises to working current levels, and NEW[®] is generated and collected in the storage container.

When the production is stopped, the brine pump is turned off, the voltage on the cell is turned off, and the input valve is closed.

11.8.2 Emergency / Security Shutdown

Aquaox Systems automatically shut down when situations which require automatic shut-down are listed below, and are described in the following sections.

- Flow / No Flow
- Exceeding Maximal Current
- Not Meeting Minimal Current
- Exceeding Maximal Temperature

11.8.2.1 Flow / No Flow

A flow sensor monitors the water flow to the Aquaox System. If the water flow is interrupted causing a no-flow situation, the internal processor shuts down all voltage to the cells, turns off the brine pump and gives a visual and sound alarm signal until problem has been solved. This puts the generator in waiting mode, and production is resumed when water flow is measured.

11.8.2.2 Exceeding Maximal Current

A current sensor monitors the current to Aquaox System. Aquaox Systems are electronically controlled to protect against overload by a current breaker (RCD). This RCD will shutdown all voltage to the cell until the RCD is manually switched on again.

11.8.2.3 Not Meeting Minimal Current

A current sensor monitors the current to the Aquaox System. When the current on the monitor is lower than the required current, the brine volume should be manually adjusted by the operator.

11.8.2.4 Maximum Temperature

A temperature sensor monitors the temperature of the cooling block. If the temperature exceeds the maximal programmed temperature, the internal processor shuts down all voltage to the cells, turns off the brine pump and gives a visual and sound alarm signal until problem has been solved. This puts the generator in waiting mode, and production is resumed when normal temperature is measured.

11.8.3 Manual Intervention in Automatic Operation

Manual intervention of the operator may be required in case of an emergency /security shutdown, as well as when periodically adding NaCl into the salt container. If the Aquaox System cannot restart the production of the NEW[®], the problem must be resolved manually by the operator.

11.9 Maintenance

The maintenance needs of Aquaox Systems are nominal, particularly for systems using good quality salt. The procedures listed below should be followed to ensure maximal efficiency of the equipment.

11.9.1 Daily Maintenance

- Check the amount of NaCl in the salt hopper to ensure it is adequate for the output required
- Check the unit for obvious problems such as leakage
- Check the flow meter for adequate flow
- Check the current meter for normal working current

11.9.2 Weekly Maintenance

- Carry out the daily maintenance schedule
- Check the pH, ORP and active chlorine levels of freshly produced NEW[®] and of NEW[®] in collecting container

11.9.3 Yearly Maintenance

A full calibration should be performed on the Aquaox System by a trained technician only.

11.10 Training

Operating an Aquaox System is simple, and each Aquaox System is supplied with an instruction manual. However, with the installation of each Aquaox System, the future operator is trained. On the day that the Aquaox System is installed and transferred to the user, Aquaox transfers the responsibilities of operating the Aquaox System to the trained operator.

12.0 Definitions

12.1 NEW[®] Technology

What is Total Chlorine?

Total Chlorine is chlorine that is present in free or combined (bound) form, or in both forms.

What is Free Available Chlorine?

Free Available Chlorine (FAC) is chlorine that is present in the form of Hypochlorous Acid, hypochlorite ions or as dissolved elemental chlorine. FAC includes all chlorine species that are not combined with ammonia (or other nitrogenous compounds) to form chloramine. It is 'free' in the sense that it has not yet reacted with anything, and 'available' in the sense that it can and will react if needed.

What is Combined Chlorine?

Combined Chlorine is that fraction of the total chlorine that is present in the form of chloramines or organic chloramines. In other words: Chlorine that is bound to other elements or organic compounds but is still an effective disinfectant. Combined chlorine has been found to be more effective than free chlorine in controlling post-disinfection bacterial growth. Chloramines are an example of combined chlorine.

What is Total Residual Chlorine?

Total Residual Chlorine (TRC) is the sum of free available residual chlorine and combined (bound) residual chlorine. It is the amount of measurable chlorine remaining after treating water with chlorine; i.e., the amount of chlorine left in water after the chlorine demand has been satisfied

What is Free Available Residual Chlorine?

Free Available Residual Chlorine (FRC) is Free Available Chlorine after treating the water with chlorine. It is that portion of the total available residual chlorine composed of Dissolved Chlorine gas (Cl_2), Hypochlorous Acid (HOCl), and/or Hypochlorite Ion (OCl^-) remaining in water after chlorination. This does not include chlorine that has combined with ammonia, nitrogen, or other compounds.

What is Combined Residual Chlorine?

Combined Residual Chlorine is Chlorine that has reacted with organics to form chloro-organics and chloramines. This is a chlorine residual that, because it has reacted with other chemicals in the water, has lost some of its disinfecting strength.

What is Chlorine Demand?

Chlorine Demand is the difference between the amount of chlorine added to water and the amount of residual chlorine remaining after a given contact time. Chlorine demand may change with dosage, time, temperature, pH, and nature and amount of the impurities in the water.

What is Chlorine Requirement?

Chlorine Requirement is the amount of chlorine which is needed for a particular purpose. Some reasons for adding chlorine are reducing the number of bacteria, obtaining a particular chlorine residual, or oxidizing some substance in the water. In each case, a definite dosage of chlorine will be necessary. This dosage is the chlorine requirement.

What are Chloramines?

Chloramines are compounds formed by the reaction of chlorine and ammonia-nitrogen in water.

What is Hypochlorous Acid?

Hypochlorous Acid (HOCl) is a weak acid which forms when chlorine dissolves in water. It is used as a bleach, an oxidizer, a deodorant, and a disinfectant.

What is Sodium Hypochlorite?

Sodium Hypochlorite (NaClO) is a chlorine compound commercially produced by the electrolysis of Sodium Chloride solution.

What is Sodium Chloride?

Sodium chloride (NaCl) is also known as common salt or table salt. Sodium chloride is the salt most responsible for the salinity of the ocean and of the fluid of many multi cellular organisms, and is commonly used as food preservative.

What is Sodium Chlorite and Sodium Chlorate?

Sodium Chlorite is derived indirectly from Sodium Chlorate. Sodium Chlorate is synthesized from the electrolysis of a hot Sodium Chloride solution in a mixed electrode tank. It can also be synthesized by passing Chlorine gas through a Sodium Hydroxide solution. The main oxidation by-products of Chloride Dioxide are the *chlorite* and *chlorate* ions. It has been reported that chlorite and chlorate ions at concentrations > 100 mg/L can cause hematological effects in mice, rats, monkeys, cats and humans. For this reason it is currently recommended to monitor the chlorite and chlorate ions residuals in treated water. Sodium Chlorite should be protected from inadvertent contamination by organic materials to avoid the formation of an explosive mixture.

What is Sodium Hydroxide?

Sodium Hydroxide (NaOH), also known as lye or caustic soda, is produced (along with chlorine and hydrogen) via the chloralkali process. This involves the electrolysis of an aqueous solution of Sodium Chloride. The Sodium Hydroxide builds up at the cathode, where water is reduced to Hydrogen gas and Hydroxide ion.

What is Chlorine Dioxide?

Chlorine Dioxide is a reddish-yellow gas which is one of several known oxides of Chlorine. Chlorine Dioxide is relatively stable in the gas and liquid states, but can explode easily. For this reason, it is never handled in its pure form.

What is Hydrogen Peroxide?

Hydrogen Peroxide (H₂O₂) is a clear liquid, slightly more viscous than water. It has strong oxidizing properties and is useful as a powerful bleaching agent and a disinfectant.

Remark: NEW[®] has 50-500ppm Free Available Chlorine which consists of Hypochlorous Acid, Sodium Hypochlorite and Sodium Chloride. Addition of NEW[®] to water results in less formation of THM's and Chloramines. No Sodium Chlorite and Chlorates ions are found in NEW[®]. Alkaline water consists Sodium Hydroxide

12.2 Bacteria, Pathogens, Germs, Viruses, Fungi, Molds, Spores and Microorganisms

What are Bacteria?

Bacteria are single-celled living organisms ubiquitous in every habitat on Earth. They are both harmful and useful to the environment and animals, including humans. Some bacteria act as pathogens and cause diseases and illness.

What are Anaerobic Bacteria?

Anaerobic bacteria are bacteria that do not require oxygen for growth. These bacteria cannot live or grow in the presence of oxygen.

What are Aerobic Bacteria?

Aerobic bacteria are bacteria that have an oxygen-based metabolism. Aerobes use oxygen to oxidize substrates (for example sugars and fats) in order to obtain energy.

What is a Pathogen?

A pathogen or infectious agent is a biological agent that causes disease or illness to its host. A pathogen can be a bacteria, a virus, fungi or a parasite. Advances in food safety, hygiene, and water treatment have reduced the threat from some pathogens.

What is a Germ or Bug?

A germ or bug is an informal term for a pathogen, particularly bacteria.

What is a virus?

A virus is a submicroscopic parasitic particle that infects cells in biological organisms. Examples of diseases caused by viruses include the common cold, smallpox, and HIV. Connections are being studied which may link viruses to neurological diseases such as multiple sclerosis and chronic fatigue syndrome.

What is Fungi?

A fungus (plural fungi) is an organism that digests its food externally and absorbs the nutrient molecules into its cells. Fungi occur in every environment on earth and play very important roles in most ecosystems. Some fungi are parasites on plants and animals, including humans. They are responsible for numerous diseases, such as athlete's foot and ringworm in humans.

What is Yeast?

Yeasts are single-celled fungi, a few species of which are commonly used to leaven bread and ferment alcoholic beverages. A few yeasts, such as *Candida albicans*, can cause infection in humans.

What is Mold?

Molds, or mould, are various fungi that cover surfaces in the form of biofilm and usually produce masses of spores. Mold is often a problem in damp areas such as basements and bathrooms, and after floods. It can be seen on surfaces of walls but also grows deep within, and produces a distinctive dusty, slightly pungent smell. It grows on food in closed containers, even in refrigerators.

What are Spores?

A spore is a reproductive mechanism that is adapted for dispersion and surviving for extended periods of time in unfavorable conditions. The spore can develop into a new organism by dividing by mitosis without fusing with another cell. The term may also refer to the resting stage in the life cycle of some bacteria, more commonly referred to as the endospore. Fungi that produce spores are known as sporogenous, and those that do not are asporogenous.

What is a Microorganism or a Microbe?

A microorganism or microbe is an organism that is microscopic (invisible to the naked eye). Microorganisms are often illustrated using single-celled, or unicellular organisms.

What is Algae?

Algae range from single-celled organisms to multi-cellular organisms, some with fairly complex differentiated form and (if marine) called seaweeds. All algae have photosynthetic machinery ultimately derived from the cyanobacteria, and produce oxygen as a by-product of photosynthesis. Algae are usually found in damp places or bodies of water and thus are common in terrestrial as well as aquatic environments.

What is Biofilm?

A biofilm is a complex aggregation of microorganisms marked by the excretion of a protective and adhesive matrix. Formation of a biofilm begins with the attachment of free-floating microorganisms to a surface. These first colonists adhere to the surface, and if they are not immediately separated from the surface, they can anchor themselves more permanently using cell adhesion molecules. Once colonization has begun, the biofilm grows through a combination of cell division and recruitment. Biofilms can contain many different types of microorganisms, such as bacteria, protozoa and algae. Biofilms have been implicated in a wide variety of microbial infections in the body, including common problems such as urinary tract infections, catheter infections, middle ear infections, formation of dental plaque, gingivitis and coating contact lenses. Biofilms cause infection in drinking water and can lead to corrosion of water systems.

Remark: NEW[®] can successfully eradicate biofilm, and is a highly effective disinfectant against Bacteria, Viruses, Pathogens, Germs, Bugs, Spores, Algae, Yeast, Mold and Fungi .

12.3 Reduction, Oxidation, Disinfection, Sanitation, Deodorizing and Sterilizing**What is Reduction?**

Reduction describes the gain of electrons by a molecule, atom or ion.

What is Oxidation?

Oxidation describes the loss of electrons by a molecule, atom or ion.

What is an Oxidizing Agent?

Substances that have the ability to oxidize other substances are said to be oxidative and are known as oxidizing agents, oxidants or oxidizers. An oxidizing agent is a chemical compound that oxidizes another substance in electrochemistry or ORP reactions. The oxidant removes electrons from another substance, and in doing so, becomes reduced in the process.

What is Disinfection?

Disinfection is the destruction of pathogenic and other kinds of microorganisms by physical or chemical means. Disinfectants are antimicrobial agents that are applied to non-living objects to destroy microorganisms, the process of which is known as disinfection.

What is Sanitation?

Sanitation is a term for the hygienic disposal or recycling of waste materials, particularly human excrement. Sanitation is an important public health measure which is essential for the prevention of disease.

What is Deodorizing?

Deodorants inhibit the growth of bacteria which cause odors. Deodorants are usually alcohol based which gives an effective antibacterial kill.

What is Sterilization?

Sterilization is the elimination of all transmissible agents (such as bacteria and viruses) from a surface, a piece of equipment, food or biological culture medium.

Remark: NEW[®] is effective in oxidation, disinfection, sanitation, deodorizing and sterilization processes. NEW[®] is therefore an effective oxidizer, disinfectant, deodorant and sterilizing agent.

12.4 Pesticide, Germicide, Bactericide, Fungicide, Virucide

What is a Pesticide?

Any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest. A pesticide may be a chemical substance, superoxidated water or biological agent (such as a virus or bacteria) used against pests including insects, plant pathogens, weeds, mollusks, birds, mammals, fish, nematodes (roundworms) and microbes that compete with humans for food, destroy property, spread disease or are a nuisance. Pesticides are usually, but not always, poisonous to humans.

What is Biocide?

A biocide is a Chemical substance capable of killing different forms of living organisms. A biocide can be:

- A pesticide, which includes fungicides, herbicides, algicides and rodenticides.
- An antimicrobial, which includes germicides, antibiotics, antibacterials, antivirals, antifungi, antiprotozoas and antiparasites.

What is an Antiseptic?

An antiseptic is a substance that prevents the growth and reproduction of various microorganisms (such as bacteria, fungi, protozoa and viruses) on the living tissues/skin of the body. Some are true germicides, capable of destroying the bacteria, whilst others merely prevent or inhibit their growth. The objective of antiseptics is to reduce the possibility of infection by germs.

What is a Fungicide?

Fungicides are chemical compounds used to prevent the spread of fungi in gardens and crops, which can cause serious damage to the plants. Fungicides are also used to fight fungal infections.

What is a Bactericide?

A bactericide is a substance that kills only bacteria. Bactericides are either disinfectants, antiseptics or antibiotics.

What is a Sporicide?

A sporicide is a substance that kills spores or spore-forming fungi and bacteria.

What is a Viricide?

A viricide is an antiseptic which reliably deactivates or destroys a virus.

Remark: NEW[®] can be successfully used as a pesticide, biocide, Antiseptic, Fungicide, Bactericide, Sporicide or Viricide.

12.5 Toxicity, Cytotoxicity, Acute Toxicity, Chronic Toxicity, Genotoxicity

What is Toxicity?

Toxicity is a measure of the degree to which something is toxic or poisonous.

What is Cytotoxicity?

Cytotoxicity is the quality of being toxic to cells. Examples of toxic agents are a chemical substance or an immune cell.

What is Acute Toxicity?

Acute toxicity describes the adverse effects of a substance which result either from a single exposure or from multiple exposures in a short space of time (usually less than 24 hours). To be described as acute toxicity, the adverse effects should occur within 14 days of the administration of the substance.

What is Chronic Toxicity?

Chronic toxicity is a property of a substance that has toxic effects on a living organism when that organism is exposed to the substance continuously or repeatedly, often at low levels, over a long time period (months or years).

What is Genotoxicity?

Genotoxic substances are those chemical compounds capable of causing genetic mutation and of contributing to the development of tumors.

Remark: NEW[®] proved not to be toxic to animals, insects and humans. Toxicity levels are negligible due to low chemical load in NEW[®]

12.6 Environmental, Biodegradable, Metastable, Electrons, Ion, Atoms**What is Environmentally Friendly?**

Minimizing harm to the natural world, e.g. by using biodegradable ingredients

What is Biodegradable?

Able to decompose naturally; made of substances that will decay relatively quickly as a result of the action of bacteria; can be broken down into elements such as carbon that are recycled naturally

What is Metastable?

Metastability in molecules is the ability of a non-equilibrium chemical state to persist for a long period of time. Metastable liquids are liquids that persist in their existing equilibrium when undisturbed, but are able to pass to a more stable equilibrium when sufficiently disturbed by means of oxidation. Usually, metastability is due to a relatively slow phase transformation. In general, as long liquids are airtight and are not subject to UV-light or heat, they remain in the same chemical state.

What is an Electrolyzed (Electrochemically Activated) Substance?

An electrolyzed substance is any material substance obtained by means of electrolysis. Electrolyzed substances are metastable and biodegradable.

What is a Biological Substance?

A biological substance is any material derived from animal products or other biological sources.

What is a Chemical Substance?

A chemical substance is any material used in or obtained by a process in chemistry. A chemical element is a substance that cannot be decomposed or transformed into different substances by ordinary chemical methods.

What is an Atom?

The smallest particle of an element is an atom, which consists of electrons centered about a nucleus of protons and neutrons. A chemical element consists of atoms with the same number of protons.

What are Electrons?

An electron is a lightweight particle that carries an electric charge. The electron participates in electromagnetic interactions. Together with the nucleus, electrons make up atoms; they are responsible for chemical bonding. The flow of electricity in the electrochemical cells is primarily due to the movement of electrons.

What is a Molecule?

A molecule is the smallest particle of an element or compound that retains the chemical characteristics of the element or compound. A chemical compound consists of molecules composed of the same atoms in the same configuration.

What is an ion?

An ion is an atom or group of atoms with a net electric charge, having lost (cation) or gained (anion) an electron. A negatively charged ion, which has more electrons in its electron shells than it has protons in its nuclei, is known as an anion, for its attraction to anodes; a positively-charged ion, which has fewer electrons than protons, is known as a cation for its attraction to cathodes.

Remark: NEW[®] is not harmful for the environment. It is biodegradable and metastable, and is not a chemical or biological agent, but an electrochemically activated liquid.

12.7 Methods of Usage**What is Dosing?**

Dosing involves feeding a disinfectant (NEW[®]) into a process fluid, atmosphere or to another media in intervals to give NEW[®] sufficient time to react or show the results

What is Misting?

A mist is a phenomenon of a liquid in small droplets floating through air. Misting is executed with the help of aerosols. Generally, misting NEW[®] causes the floor to get wet.

What is Fogging?

Fog is a cloud in contact with the ground. Artificial fog is generated by means of aerosols or is created by vaporizing water. Fogging of NEW[®] will not cause the floor to get wet.

What is Spraying?

Spraying involves disinfecting a surface by applying NEW[®] using a spray gun or high pressure cleaner. Spraying allows NEW[®] sufficient contact time with the surface for disinfection.

What is Soaking?

Soaking involves placing a subject in a bath and allowing the subject to become saturated or permeated with NEW[®].

What is Rinsing?

Rinsing is accomplished by washing lightly, as by pouring NEW[®] into or over a subject.

What is Immersing?

Immersing involves plunging a subject into or placing it under a liquid, also known as dipping or sinking.

Remark: NEW[®] may be dosed, misted, fogged, and sprayed to disinfect water, surfaces and air. Items may be soaked or immersed in NEW[®] for disinfection.

12.8 pH, ORP , Conductivity, TDS and Salinity

What is pH?

pH (potential of hydrogen) is a measure of the activity of hydrogen ions (H⁺) in a solution and, therefore, its acidity or alkalinity. Most substances have a pH in the range 0 to 14. Aqueous solutions with pH values lower than 7 are considered acidic, while pH values higher than 7 are considered alkaline. A pH of 7 is considered to be pH neutral.

What is ORP?

ORP or Oxidation-Reduction Potential of redox reactions are the foundation of electrochemical cells. Redox reactions include all electrochemical processes in which atoms have their oxidation number (oxidation state) changed. The term REDOX comes from the two concepts of reduction and oxidation. Oxidation describes the loss of an electron by a molecule, atom or ion, whereas reduction describes the gain of an electron by a molecule, atom or ion.

What is Conductivity?

Electrical conductivity is a measure of a material's ability to conduct an electric current.

What are TDS?

Total Dissolved Solids (TDS) are the total amount of mobile charged ions, including minerals, salts or metals dissolved in a given volume of water. They are expressed in units of mg per unit volume of water (mg/L), and are also referred to as parts per million (ppm). TDS is directly related to the purity of water and the quality of water purification systems, and affects everything that consumes, lives in, or uses water, whether organic or inorganic. High TDS indicates hard water, which causes scale buildup in pipes and valves and inhibits performance. Since TDS is related to water hardness, using a TDS meter is the first step in determining the degree of hardness of water.

What is Salinity?

Salinity is the saltiness or dissolved salt content of a body of water. Salinity influences the types of organisms that live in a body of water. As well, salinity influences the kinds of plants that will grow either in a water body, or on land fed by water (or by ground water). Organisms (mostly bacteria) that can live in very salty conditions are classified as halophiles.

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14.0 Appendices

Appendix A Microbiological Sampling Methods

The following describes four basic methods for enumeration of bacteria on surfaces, (1) Swab rinse, (2) Rinse, (3) Agar Contact, and (4) Direct Surface Agar Plating.

1.0 The Swab Rinse

The swab rinse is a commonly used method which has many forms. Basically, a sterile swab is rubbed over the surface of an object to be sampled (the swab may be pre-moistened with sterile fluid if the surface is dry). The tip of the swab is broken into a tube containing a sterile diluent, shaken, and the rinse fluid plated onto an appropriate culture medium. There may be poor recovery of bacteria from the surfaces sampled, possibly because of the nature of the surface, or the amount of pressure applied to the swab, or the time and the speed of application to the surface. Different people use different swabbing techniques, so the results may not be reproducible between samples or between laboratories. The cotton portion of the swab also retains some of the microorganisms, causing reduced counts. Various modifications have been made to reduce these errors. A sterile metal template can be used to outline a known area, inside which the swabbing is performed. The time of swabbing can be standardized, and the size of the swab and the amount and type of material used to make the swab can be specified. In addition, replicate swabs can be used on the same area to confirm results.

2.0 The Rinse Method

With this method, the contaminated surface is either immersed (as in the case of small objects) in a sterile fluid, or the fluid is brought into contact with the surface being examined. This may require aseptic removal of part of the surface into the diluent. Though essentially more accurate since all the surface, or a known section of it, is being sampled directly by the diluent fluid, there are certain disadvantages. Recovery from the surface may be low if the surface is such that it tends to retain the bacteria. Thus, with poultry skin, recovery by this method is low unless special precautions are taken to remove the bacteria, e.g. by shaking an area of skin with an abrasive material such as rough sand in the sterile diluent. Greasy surfaces are also difficult to sample by this method, and large objects or large areas of surfaces mean that only a small proportion can be sampled, and the results may not be representative of the whole due to uneven spread of contamination.

3.0 Agar contact methods

There are many modifications of the agar contact method. All methods basically involve pressing a sterile nutrient agar surface against the surface to be sampled. The agar is then incubated and the adhering microorganisms are counted. This method is most useful for smooth flat surfaces, and since dilution is not possible, only small numbers of contaminants can be enumerated. Rough surfaces, heavily contaminated, or those contaminated by spreading bacteria or molds are not suited to the method if enumeration is required.

Microbiological sampling of food contact surfaces is useful for determining the degree of cleaning and sanitizing. The RODAC method is an agar contact method that gives an estimate of the microorganisms surviving the sanitation process, and repeated use of these tests provides information which can be used to judge the sanitary quality of clean equipment and food contact surfaces and the effectiveness of the cleaning program.

4.0 Direct surface agar plating

Contaminants on surfaces can be detected by the direct surface agar plate (DSAP) method, where sterile melted agar is poured over the surface to be sampled and left to solidify under a sterile cover. After incubation, the colonies at the interface are counted. Small items can be placed in a petri dish and covered with agar. This is mainly a laboratory technique since food plant surfaces are generally large, fixed, and cannot be incubated at a desired temperature. It is not applicable to dirty surfaces, since growth becomes confluent.