EAU TECHNOLOGIES

SafeWater™

White Paper

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SafeWater™

EXECUTIVE SUMMARY

Originally developed for the production of chlorine in swimming pools, electrolysis technology has been advanced to enable the production of valuable cleaning and sanitizing solutions. When sodium chloride is subjected to electrolysis with a dividing membrane between the electrodes, two separate solutions are produced. These are primarily hypochlorous acid and sodium hydroxide at the anode and cathode respectively.

Hypochlorous acid is a powerful sanitizer and cleaning agent and is substantially more effective than hypochlorite. The soil removal process is fast and effective without the need for heating.

This new technology revolutionizes CIP and sanitation procedures. It assists in reducing the carbon footprint, saves energy and the costs of expensive formulated chemicals.

INTRODUCTION TO EAU TECHNOLOGIES

VISION AND COMMITMENT

EAU Technologies, Inc. is an innovative technology and engineering company recongized as a leading supplier of water electrolysis technology in the United States. Our primary market focus in on Clean-In-Place (CIP) applications, especially in food and beverage processing. Our products reduce cost, improve water stewardship, reduce energy use, reduce environmental impact, and improve the safety of employee working environments. We are committed to helping processors adopt more sustainable manufacturing systems and reduce their dependency on harsh chemicals for cleaning and sanitizing. Our fluids are generated on-site using safe to handle and safe for the environmnet ingredients.

CUSTOMER FOCUS

Founded in 1998, EAU Technolgies has been the leader in innovating technologies that will help our customers adopt electrolyzed water as a safe and sustainable alternative to traditional methods for cleaning and sanitizing. Continuous research and development based on our customer needs, has allowed us to innovate solutions which provide complete control over volume, quality and sustainablity. We remain steadfast in our commitment to provide the best-in-class solutions for on-site production of electrolyzed water for our customers.

EAU Technologies SafeWater™

FUNDAMENTALS OF SAFEWATER™

Electrolysis of common salt with a dividing membrane between the electrodes results in two separate solutions suitable for sanitation (Anolyte) and CIP (Catholyte) – hypochlorous acid (HOCL) and sodium hydroxide (NaOH) being the main constituents. Hypochlorous acid, a weak acid that also occurs naturally in the body to combat infection, is a powerful sanitizer and cleaning agent that is substantially more effective than hypochlorite. It sanitizes rapidly and effectively without the need for heating. This new technology revolutionizes CIP procedures. It helps reduce carbon footprint, shortens changeover time and saves energy as well as the costs of expensive, formulated chemicals. The process of deposit removal is fast and effective without the need for heating. However, when dealing with heavy mineral deposits and pronounced fouling it may be necessary to complement with traditional CIP procedures.

The fundamentals of using natural drinking water with just a bit of food salt added and applying an electrical current to produce a natural disinfectant that is identical with nature's own have elevated the status of natural disinfection in the dairy, food and beverage industries as an environmentally friendly solution.

The fact that the process is based upon simple electrolysis using only natural ingredients such as water and salt means that SafeWater is a truly sustainable solution.

THE TECHNOLOGY

One of the most intriguing things about SafeWater is its disinfection capabilities. In principle, SafeWater has two main capabilities within bacteria control:

- Keeping the water free of bacteria by limiting further growth. This is applicable for water holding tanks and supply pipe lines
- Performing real disinfection of stainless steel surfaces contaminated by bacteria. This applies to biofilm, but more importantly for food and beverage producers, SafeWater can kill bacteria both inside and outside process equipment before production starts

EAU Technologies has performed a number of process equipment disinfection tests that confirms the disinfection capabilities of SafeWater on process equipment. Bacteria analyses confirm close to zero bacteria on stainless steel surfaces and in final rinse water.

Usual levels of bacteria are down to <10 CFU/ml and bacteria log reduction of 2-5 is often seen (see table 1).

SafeWater is also sporicidal (kills spores), but efficiency is lower than against bacteria, possibly necessitating a longer contact time and/or higher concentration/temperature.

Usually the spore content present is significantly lower than bacteria content. Thus the kill rate in log reduction does not normally need to be as high as for bacteria.

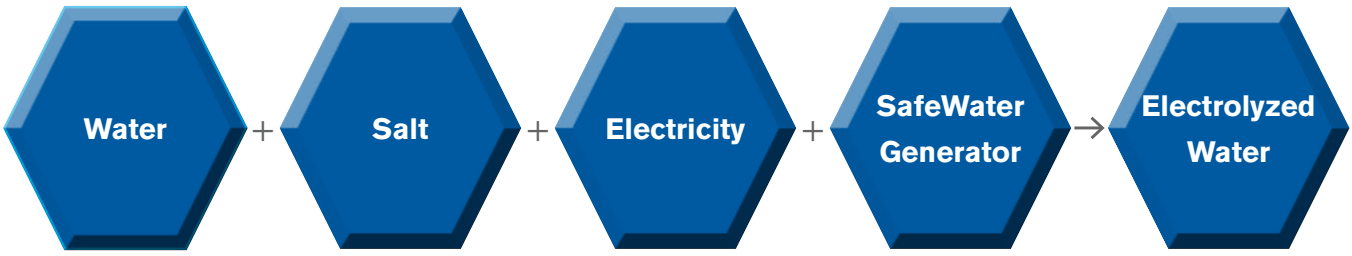

Fig. 1: Fundamentals of SafeWater™ technology

ORGANISM	STRAIN	POSITIVE CONTROL CFU/100 ML	CFU/100 ML	REDUCTION
E.Coli	NCIMB 8545	1.1×10^7	<1	1.1×10^7
Salmonella Tryphimurum	NCIMB 8545	1.6×10^7	<1	1.6×10^7
Listeria monocytogenes	NCTC 11994	1.9×10^7	<1	1.9×10^7
Staphylococcus aureus	NCIMB 9518	2.4×10^7	<1	2.4×10^7
Streptococcus faecalis	NCIMB 775	7.7×10^6	<1	7.7×10^6
Pseudomonas aeruginosa	NCIMB 9027	4.8×10^6	<1	4.8×10^6
Aspergillus niger	ATCC 16404	7.0×10^4	<1	7.0×10^4
Candida albicans	ATCC 10231	6.0×10^4	<1	6.0×10^4

Table 1: Typical bacteria microorganisms against which SafeWater has a confirmed kill effect.

Tested using standard suspension method with a 2 minute contact time. Source Microchem.

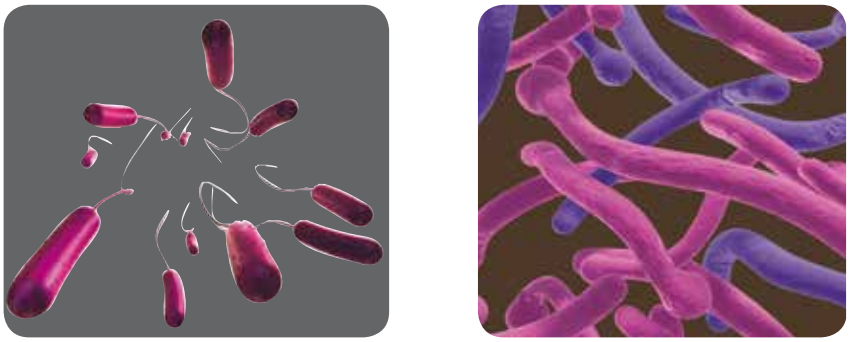

Fig. 2: E.Coli strains and Candida

Another interesting study on Biofilm removal was performed by Bonn University.

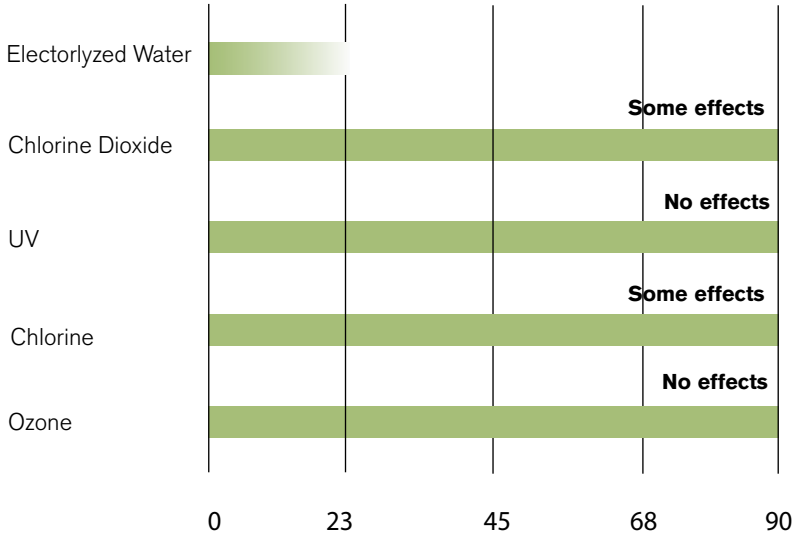

Fig.3: Biofilm removal with Activated Water (similar to SafeWater), Universitäts-klinikum Bonn.

Fig. 3 shows a comparison between SafeWater and traditional, well-known sanitizer and their effect upon biofilm removal as a function of time. As can be seen, the traditional sanitizer showed only little or no effect after 90 days of exposure. Activated Water (similar to SafeWater), on the other hand, removed the biofilm completely after 23 days.

An added strong benefit is the ability of SafeWater to clean food or beverage industrial process equipment. In order to clean process equipment, SafeWater needs to be applied in a slightly higher concentration than for disinfection. Usually a concentration of 40-50 ppm (parts per million) is used for cleaning purposes. Remember that we are still talking parts per million and not percentages. This still constitutes a very low concentration and subsequently a low consumption of food grade salt.

REDUCTION POTENTIAL (ORP)

Besides producing a powerful and natural sanitizer (HOCL), the SafeWater generator (plate configuration) also produces large amount of "ready-to-use" caustic electrolyte that is a highly efficient cleaning agent. Due to the content of sodium hydroxide (NaOH) produced during the electrolytic process, the liquid also has a large intrinsic cleaning and saponification potential owing to its large negative reduction potential (ORP).

The ORP is the actual secret behind the impressive performance of SafeWater despite relatively low concentrations of caustic (pH 11-11.5) as it reacts with the soil and removes it from the steel surface. While the Catholyte has a large negative ORP that facilitates cleaning the Anolyte (HOCL) has a large positive ORP that has a significant synergistic effect with hypochlorous acid. The electrolyzed oxidative water with high positive ORP damages the pathogen's cell membrane by inhibiting its osmotic protein pumps. This allows the sanitizer to enter the cell and cause it to burst, hence the impressive kill effect. Elimination of pathogens happens very quickly and can be regarded as a physical abolition. This is a distinctive property in comparison with traditional sanitizer used in food and beverage processing today, as this method does not create resistant strains of pathogens and does not leave any chemical residue.

Disposal of SafeWater after use is quite sustainable as it is immediately neutralized upon contact with even minor amounts of organic materials on the way to or at the waste water treatment plant. A major disposal advantage is that the water contains no dangerous disinfection chemicals of any kind.

Caution, however, should be observed upon direct contact with acids. If the sanitizer is mixed with acid and the pH is

Fig. 4: Cleaning test on a process tank soiled with yogurt milk. The cleaning procedure was mild caustic cleaning followed by 43 ppm HOCL cleaning. The soiled tank is on the left and the completely clean tank after cleaning is on the right.

lowered, chlorine gas is produced (see figure 5). And if sufficient ventilation is not in place, this gas is harmful and dangerous. Preventive measures must be taken in order to prevent this from happening and procedures must be in place in case it does happen. The SafeWater unit is equipped with venting connections to ensure that any gas produced is removed efficiently from the unit and the buffer tanks.

HOW IS SAFEWATER™ PRODUCED?

The principle of the SafeWater system is an electrolytic generator in which a brine solution is passed through the electrolytic cell inside the machine. When subjected to a strong electrical DC current, the salt water is split into two main products, hypochlorous acid (HOCL) and caustic (NaOH).

The SafeWater electrolysis process consists of a reaction cell with an anode and a cathode. The reactions are

At the anode: **$2Cl^- \rightarrow Cl_2$ (gas) + $2e^-$,**

At the cathode: **$2H^+ + 2e^- \rightarrow H_2$ (gas)**

The chlorine gas produced at the anode disperses into the water and the following reaction equilibration will take place:

Cl_2(gas) + H_2O <-> HOCL + HCl

Producing hypochlorous acid (HOCL) and hydrochloric acid (HCl).

This equilibration is controlled by the control of pH in the aqueous solution, as shown in fig. 5

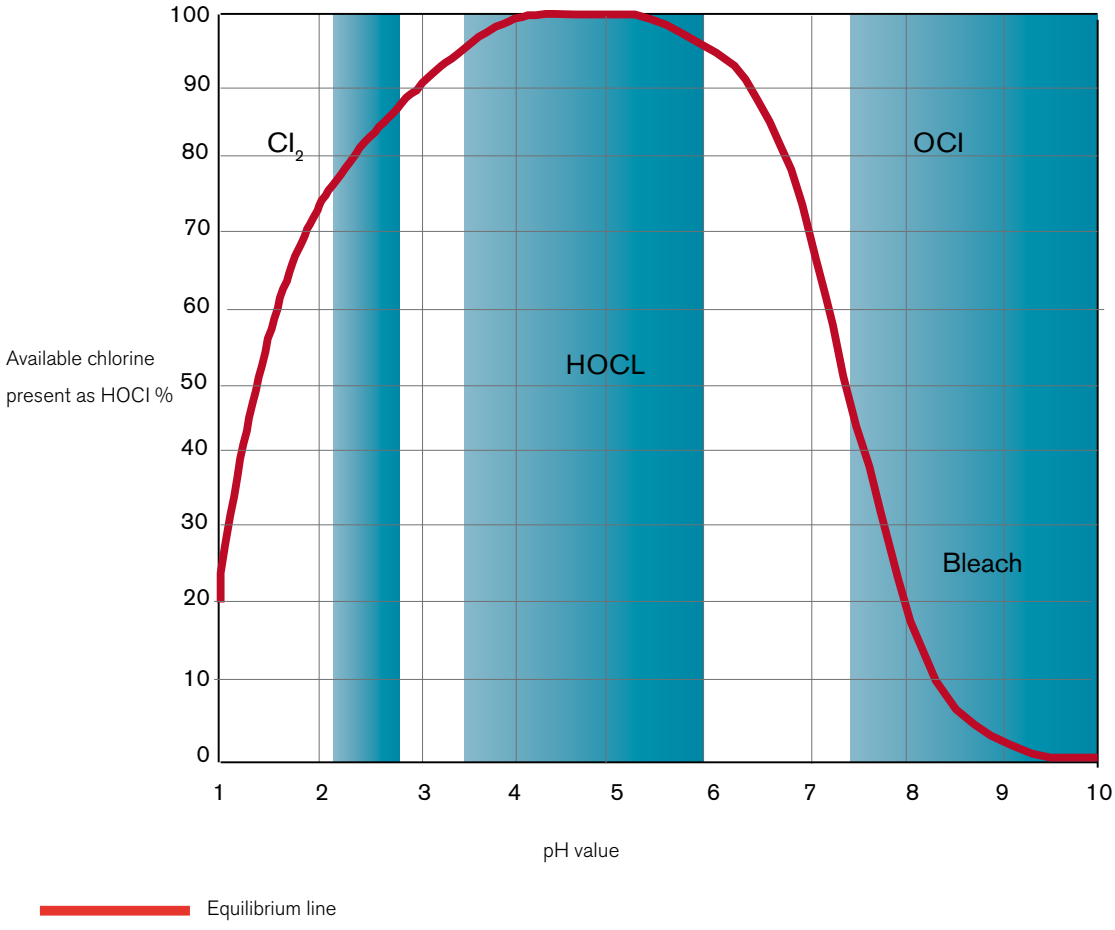

Fig. 5: Optimal pH range for hypochlorous acid formation

EAU Technologies SafeWater™

SafeWater is produced through the electrolysis of a solution of sodium chloride or sodium carbonate. In the absence of a semi-permeable membrane, a mixture of anolyte and catholyte will be produced. This is essentially sodium hypochlorite.

When a membrane is positioned between the electrodes, it is possible to separate the two electrolytes. A variation of the flow rate past the respective electrodes enables different concentrations of the two electrolytes to be obtained.

Fig. 6 shows the basic operation of the EAU Technologies' SafeWater Flat Plate cell.

Hypochlorous acid is about 50 times more effective a sanitizer than hypochlorite. It is the chemical that the body naturally produces in response to an infection. When an infection is detected, the body sends (neutrophilic) blood cells to encircle the bacteria or virus and produce hypochlorous acid. A concentration of just 0.1ppm hypochlorous acid is sufficient to secure a log 3 reduction of E.coli within 10 seconds.

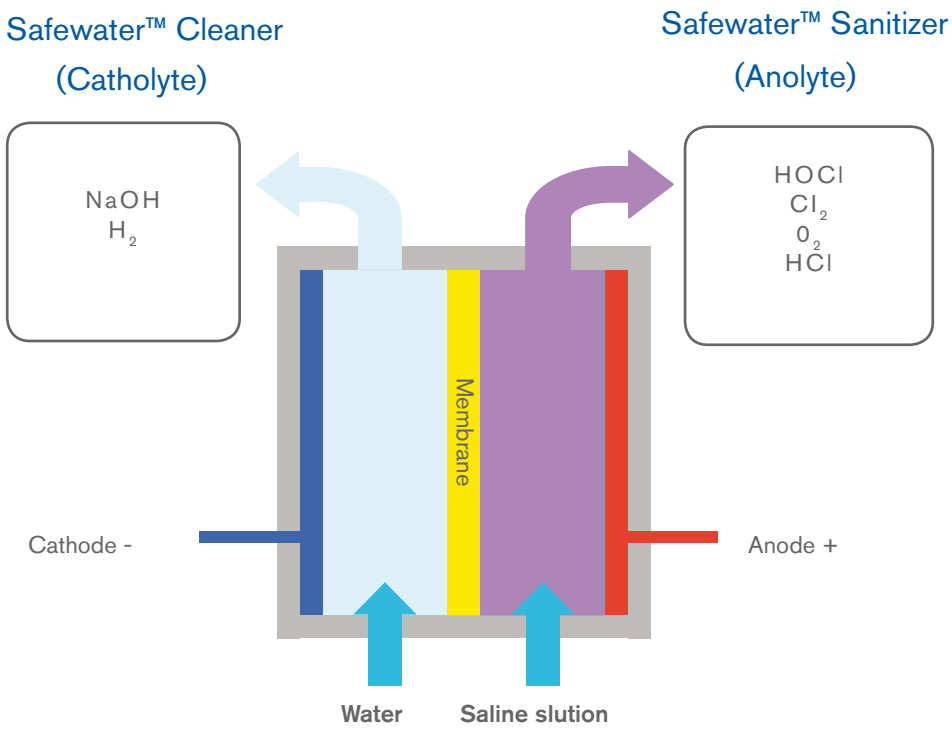

Fig. 6: EAU Technologies SafeWater Flat Plate cell with a membrane separating the cathode from the anode.

WHAT ARE THE BENEFITS AND APPLICATIONS OF EAU TECHNOGIES SAFEWATER?

SafeWater has several important benefits for beverage processors:

- Replacement of chemical detergents and sanitizers
- Improved microbial efficiency
- Destruction of all forms of pathogens
- Reduction in CIP time
- Ambient CIP
- Reduced water usage
- Improved effluent management
- Non Toxic, a true “clean” technology
- On-site, on demand generators
- Claimed to be harmless to man and the environment

Most application work has been conducted in the carbonated soft drinks industry where SafeWater is used as a replacement for conventionl sodium hydroxide and nitric acid cleaning solutions, typically with payback times down to 4 months.

HOW IS SAFEWATER INTEGRATED INTO A PROCESS FACILITY?

The SafeWater units are supplied as complete automated skid-mounted units that fill anolyte or catholyte into plastic (polyethylene) storage tanks. The anolyte and catholyte are then pumped into a normal CIP system in a similar manner to that used for filling with water. A ph probe may need to be added to the circuit. Essentially, this means minimal changes in the factory CIP system hardware. A new CIP recipe needs to be created to implement a new CIP protocal specifically for SafeWater. This new recipe typically runs faster than traditional procedures.

The SafeWater skids mounted units are designed as high-quality, skid-mounted, plug & produce solution platform for large volume applications. They are designed for dairy, beverage and food manufacturers all over the world who require reduced lead time for delivery of high-quality, low-risk solutions for plant upgrades or extensions.

Based on standardized module design, each unit is built and backed by EAU Technologies and its Global Distribution Partners. EAU Technologies leverages proven engineering and automation principles, and complies with global industry standards.

APPROVALS FOR USE OF EAU TECHNOLGIES SAFEWATER™

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Fig. 9 and 10: SafeWater HIgh and Medium Capacity Plate Generators (Empowered Water™)

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