Envirolyte USA

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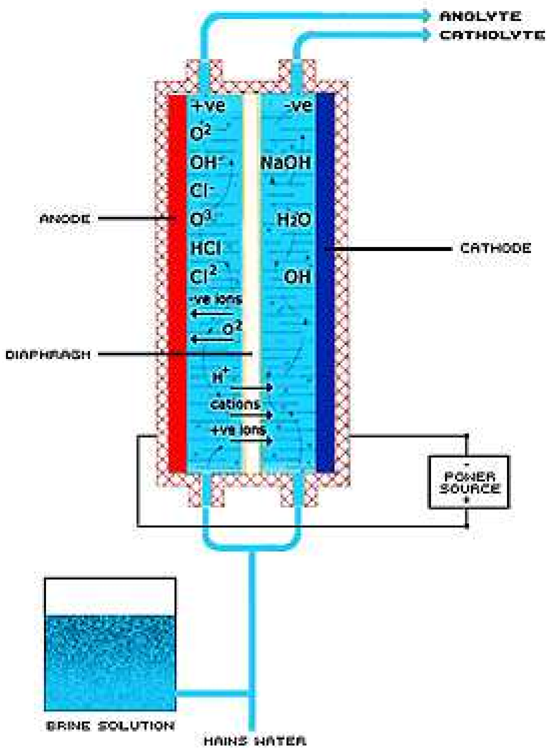
TECHNOLOGY

Envirolyte® units electrolyze salt and water (brine) using polymer or ceramic membranes to separate the positive and negative ions. As a result of the chemical reactions two types of activated solutions are produced, Anolyte and Catholyte.

The electrochemical activation of water involves the exposure of water and natural (or added) salts to a substantial difference in electrical potential. If an anode (+) and cathode (-) are placed in pure water and a direct current is applied, electrolysis of water occurs at the electrodes, leading to the breakdown of water into its constituent elements – gaseous oxygen and hydrogen.

Electroplating is a similar process, where chromium salts are added to water, a difference in potential is applied, and the chromium is deposited onto the material attached to the cathode. If sodium chloride (NaCl), or table salt, is used as a solution, the dominant electrolysis end product is various forms of chlorine and sodium hydroxide. The key Envirolyte innovation is the interposition of an ion-permeable membrane between the positive and negative electrodes as well as the design and materials used for the electrodes. The Envirolyte electrochemical reactor is divided by a patented zirconium oxide diaphragm. Certain new designs use ceramic and polymer membranes.



Schematic diagram of an electrochemical reactor, illustrating the migration and concentration of ions at the opposite poles in the reactor.

The base solution used in this reactor is a 0.5 – 1.0% solution of NaCl, which is split into two channels, one running through the anode (+) chamber and the other through the cathode (-) chamber. Salt, which in solution is in its ionized form (Na^+ and Cl^-), is exposed to a controlled difference in electrical potential between the cathode and the anode. This potential difference causes the Na^+ and Cl^- ions to migrate toward the pole of opposite charge. The specially designed membrane, which separates the two chambers, allows the ions to pass unimpeded. The net result is an enrichment of chlorine ions in the anode chamber and sodium and hydroxide ions in the cathode chamber. This creates an Anolyte solution that is primarily chlorine based and a Catholyte solution that is primarily sodium and hydroxide based. Similarly, water is also ionized extensively and will tend to migrate to the opposite pole as in the reaction below.

$$H_2 \longrightarrow H^+ + OH^-$$

The constituents of the 0,5% salt solution that has been subjected to electrolysis are listed in the table below.

	Reactive Molecules	Reactive Ions	Reactive Free Radicals
Anolyte		H^+	·
		H^+	·
	O_2	H_3O^+	$OH_2^{\cdot}$
		OH^-	·
		ClO^-	
	HOCl		$ClO^{\cdot}$
	Cl_2		$Cl^{\cdot}$
	HCl		$O_2^{\cdot}$
	$HClO_3$		
Catholyte	NaOH		
	H_2		

Reactive ions and free radicals formed in the anolyte and catholyte solutions by electrochemical activation.

Because hypochlorous acid (HOCl) is so unstable, it is generally thought of as a transient byproduct in the ubiquitous chlorine chemical family. HOCl carries with it fewer negative hydroxides than HOCl formed via disassociation from sodium hypochlorite. For this and other reasons, under a light organic load (like the light organic contaminants in water already treated by a municipality or from a normal water well), 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.

The Envirolyte electrolytic generator produces consistently high quality, pure HOCl from unassuming food grade precursors – salt (NaCl). Production of Anolyte is similar to the process of fabricating standard sodium hypochlorite (NaOCl) with one significant difference. Sodium hypochlorite combines the chlorine (Cl_2) produced in the electrolytic reaction with caustic soda (lye/sodium hydroxide) to stabilize the chlorine. Elimination of sodium and caustic soda by the use of high rejection membrane technology produces pure HOCl. With the sodium removed, the benefits of HOCl in the Anolyte become immediately evident when used as a biocide. Elimination of the caustic soda makes disinfection possible without the high pH elements associated with sodium hypochlorite. The Anolyte is delivered at a neutral pH (7-8) or lower thereby delivering high efficacy with short contact times and without the caustics.

pH	% as HOCl	% as OCl^-
8.0	22	78
7.8	33	67
7.5	48	52
7.2	66	34
7.0	72	34
6.0	96	4
5.0	100	0

The full equation may be represented like this:

$$Cl_2 + H_2O \longrightarrow HOCl + HCl$$
$$HOCl \longrightarrow OCl^- + H^+$$

HOCl is the "active ingredient." The OCl^- is a bank or reservoir of less active chlorine.

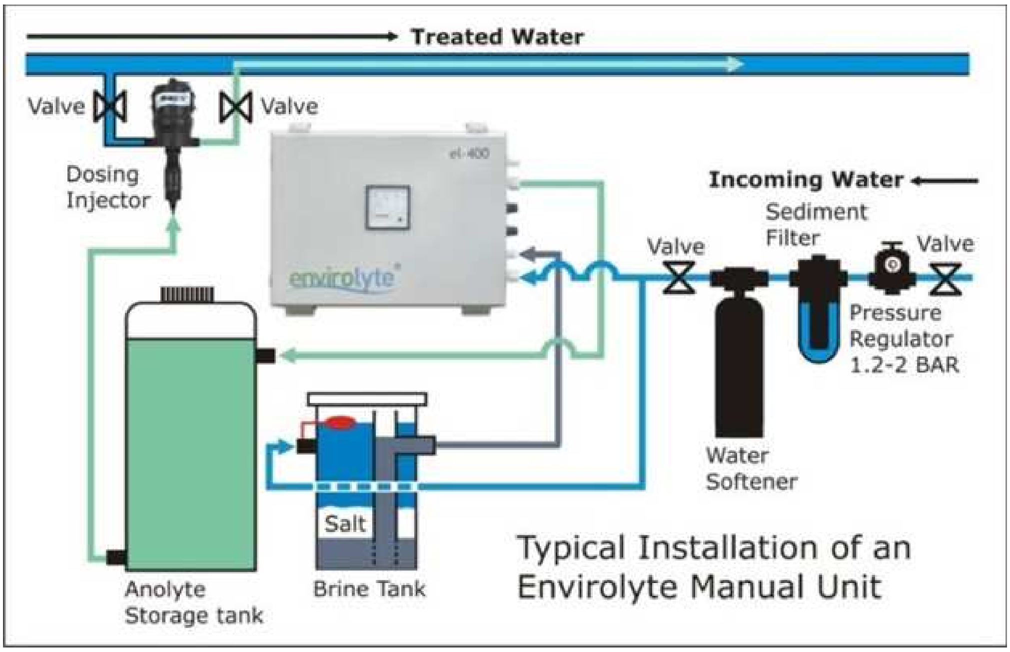
Hypochlorite ion is a poor disinfectant because the negative charge creates an obstacle to penetrating the wall of the cell. Hypochlorous acid is 100 times faster than hypochlorite ion in killing a micro-organism.

Oxidation Reduction Potential (ORP), expressed in milli-volts, describes the oxidation potential, the level of sanitizing ability, or the "killing potential" of treated water irrespective of the kind of disinfectant or the pH. Any water, for example, treated to have an ORP of greater than 500 mV for more than one hour (approximately) would be assured of being free of E.coli, Listeria, Salmonella and other pathogens. High ORP levels in Anolyte are possible due to the elimination of the caustics. This feature of the Anolyte allows for a higher level of ORP than say, Sodium Hypochlorite (NaOCl). When caustic sodium hypochlorite is used, it also simultaneously raises the pH of water and thereby dramatically reduces its efficacy (ORP). When Anolyte is used, the pH of water is not raised/slightly lowered and its efficacy (ORP) remains/is enhanced.

All water disinfection will result in the formation of by-products and Anolyte is no exception, but it 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 Anolyte is used, are held in balance at much lower levels. Thus, lower disinfection by-products are produced in the process, about 30% to 50% compared with sodium hypochlorite and other oxidants.

Anolyte produces a residual that continues to remain available based on bacterial demand. ORP levels can last for long periods of time depending on organic load. Tests show that not only is Anolyte a sanitizer and a disinfectant, but it is also sporicidal. Sporicidal tests also demonstrate that Anolyte treatment eliminates bacterial spores and biofilm. Anolyte, even at residual levels over 12 ppm in treated water, leaves no or minimal odor or chlorine taste.

Whether automated or manual, the process of producing Envirolyte solutions is similar. The schematic below shows the components of most systems, leaving out for simplicity's sake most of the features available in an automated unit.



Acidic Anolyte

Primary active components: hypochlorous acid (HClO), hyprochlorite ion (ClO^-), hydrochloric acid (HCl), chlorine (Cl_2) and oxygen (O_2).

This solution is used to disinfect or sterilize where the pH is unimportant and corrosion is not an issue. It is a powerful disinfectant against all bacteria, viruses, spores, mold, fungi and algae even when diluted in water or sprayed in the air.

Active Ingredient	500 – 700 ppm of chlorine
pH	2.0 to 3.5
ORP/REDOX	1000 to 1200

Catholyte

Primary active components: hydrogen (H_2) and hydroxide (OH^-) from sodium hydroxide, plus a small amount of hydrogen peroxide (H_2O_2)

This solution is alkaline which serves as an excellent washing liquid and can remove heavy metals from water through precipitation.

Active Ingredient	Sodium Hydroxide
pH	11.6 to 12.5
ORP/REDOX	-900 to -1100

Neutral Anolyte

Primary active components: hypochlorous acid (HClO), hyprochlorite ion (ClO^-), hydrochloric acid (HCl), chlorine (Cl_2) and oxygen (O_2).

This solution is used where pH is important or possible evaporation of active chlorine cannot be avoided. Neutral Anolyte is highly effective against a broad range of pathogens including bacteria, viruses, spores, mold and fungi.

Active Ingredient	500 – 700 ppm of chlorine
pH	5.0 to 8.5
ORP/REDOX	700 to 900