Electrolyzed Water

"It's the Right Thing to Do"

One Drop at a Time

Electrolyzed Water vs. Chlorine

Chlorine

Chlorine is one of the most commonly used disinfectants for water disinfection. Chlorine can be applied for the deactivation of most microorganisms and it is relatively cheap.

Diluted (watery) chlorine should be protected from sunlight. Chlorine is broken down under the influence of sunlight. UV radiation in sunlight provides energy which aids the break-down of Hypochlorous Acid (HOCl) molecules. First, the water molecule (H2O) is broken down, causing electrons to be released which reduce the chlorine atom of Hypochlorous Acid to chloride (Cl-).

Chlorine as a disinfectant

Chlorine is one of the most widely used disinfectants. It is very applicable and very effective for the deactivation of pathogenic microorganisms. Chlorine can be easily applied, measures and controlled. Is is fairly persistent and relatively cheap.

Chlorine has been used for applications, such as the deactivation of pathogens in drinking water, swimming pool water and wastewater, for the disinfection of household areas and for textile bleaching, for more than two hundred years. When chlorine was discovered we did not now that disease was caused by microorganisms. In the nineteenth century doctors and scientists discovered that many diseases are contagious and that the spread of disease can be prevented by the disinfection of hospital areas. Very soon afterward, we started experimenting with chlorine as a disinfectant.

Chlorine as bleach

Surfaces can be disinfected by bleaching. Bleach consists of chlorine gas dissolved in an alkali-solution, such as sodium hydroxide (NaOH). When chlorine is dissolved in an alkali solution, hypochlorite ions (OCl-) are formed during an autoredox reaction. Chlorine gas reacts with sodium hydroxide to sodium hypochlorite (NaOCl).

Bleach or Bleaching powder can also be used. This is produced by directing chlorine through calcium hydroxide (CaOH). The benefit of bleaching powder is that it is a solid. This makes it easier to apply as a disinfectant in medical areas, next to its use as a bleach. When bleach or bleaching powder dissolves, it reacts with water to Hypochlorous Acid (HOCl) and Hypochlorite Ion (OCl-).

How does chlorine disinfection work?

Chlorine kills pathogens such as bacteria and viruses by breaking the chemical bonds in their molecules. Disinfectants that are used for this purpose consist of chlorine compounds which can exchange atoms with other compounds, such as enzymes in bacteria and other cells. When enzymes come in contact with chlorine, one or more of the hydrogen atoms in the molecule are replaced by chlorine. This causes the entire molecule to change shape or fall apart. When enzymes do not function properly, a cell or bacterium will die.

When chlorine is added to water, Hypochlorous Acid is formed:

$Cl2 + H2O \rightarrow HOCl + H+ + Cl-$

Depending on the pH value, Hypochlorous Acid partly expires to Hypochlorite Ions:

$Cl2 + 2H2O \rightarrow HOCl + H3O + Cl-$

$HOCl + H2O \rightarrow H3O+ + OCl-$

This falls apart to chlorine and oxygen atoms:

$OCl- \rightarrow Cl- + O$

Hypochlorous Acid (HOCl, which is electrically neutral) and Hypochlorite Ions (OCl-, electrically negative) will form free chlorine (FAC) when bound together. This results in disinfection. Both substances have very distinctive behavior. Hypochlorous Acid is more reactive and is a stronger disinfectant than Hypochlorite. Hypochlorous Acid is split into Hydrochloric Acid (HCl) and atomair Oxygen (O). The Oxygen atom is a powerful disinfectant.

The cell wall of pathogenic microorganisms is negatively charged by nature. As such, it can be penetrated by the neutral Hypochlorous Acid, rather than by the negatively charged Hypochlorite Ion. Hypochlorous Acid can penetrate slime layers, cell walls and protective layers of microorganisms and effectively kills pathogens as a result. The microorganisms will either die or suffer from reproductive failure.

The effectively of disinfection is determined by the pH of the water. Disinfection with chlorine will take place optimally when the pH is between 5,5 and 7,5. Hypochlorous Acid (HOCl) reacts faster than Hypochlorite Ions (OCl-); it is 80-100% more effective. The level of Hypochlorous Acid will decrease when the pH value is higher. With a pH value of 6 the level of HOCL is 80%,

whereas the concentration of OCL- is 20%. When the pH value is 8, this is the other way around. When the pH value is 7, 5, concentrations of HOCL and OCL- are equally high.

The most effective disinfection takes place at the correct pH. Immediate disinfection is achieved by Hypochlorous Acid, whereas Hypochlorite Ion provides for a residual disinfecting effect. Hypochlorite Ion gradually reverts to Hypochlorous Acid which will then take care of immediate disinfection. If more residual disinfection is needed, the ratio HOCL and OCL must be almost equal. (pH 7.5).

Electrolyzed Water

Electrolyzed Water consists of Hypochlorous Acid and Hypochlorite Ions. The Ratio depends on the pH and different types of Electrolyzed Water can be produced.

Acidic Electrolyzed Water (AEC) has a pH of 3-5 and mainly consists of HOCL and CL2. It is unstable, very reactive and causes an immediate disinfecting effect. Having said so, free available chlorine (FAC) evaporates and AEC loses quickly it disinfecting power. Likewise in chlorine, it is the Hypochlorous Acid that is the active disinfectant.

The disinfecting properties of Neutral Electrolyzed Water as well as Chlorine in water are based on the Oxidising power of the free Oxygen atoms and on chlorine substitution reactions. (Reactions that form HOCL and later on the reactions that split HOCL in HCL and Oxygen.)