

THE USE OF SALT FOR ON-LINE DISINFECTANT GENERATION

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Abstract

Salt has been used commercially as a source of disinfection with chlorine since early in the nineteenth century. Since the early 1970's, there has been a movement to smaller chlorine generators most often at the point of application. The generators use saturated salt brine to make a weak sodium hypochlorite solution. The advantages will be listed as follows, but are primarily centered on safety and convenience factors. Although the rationale for using onsite generation is compelling; there are issues that are less than favorable and will also be discussed.

History and Background

The use of salt to generate disinfectant agents is as old as time. From physicians in ancient Greece and Egypt using salt as a drying agent for wounds and a digestive aid; to sailors using the salt in seawater to cleanse and disinfect wounds.

The use of salt in these applications is easily accomplished due to its ability to ionize and separate with electrical charge to basic ions and reform into associated chemicals. The antiseptic action of salt on the skin and mucous membranes has been known for a very long time. Scientific studies have now confirmed the effectiveness of salt therapy in several indications. Salt is used as support treatment for skin diseases. Salt-baths are frequently used to treat various skin conditions.

A more recent use of salt is in salt water generators (SWG) that disinfect swimming pool water. Using sodium hypochlorite as a

disinfectant for swimming pool water has been a staple for many years. Sodium hypochlorite has a long history and was developed around 1785 by Frenchman Berthollet, who developed liquid bleaching agents based on sodium hypochlorite. The earliest use was to bleach cotton. Because of its specific characteristics it soon became a popular compound.

There has always been a concern of handling strong oxidizing materials and maintenance chemicals necessary to maintain proper balance of the water. The safety aspect of handling oxidizers was one of the motivations behind the development of on-site chlorine generators. The technology was first used in swimming pools over forty years ago in Australia. During the 1970's salt water generator usage became wide spread. In the 1980's the technology began to be used in the United States. Salt water generation became prevalent in the United States in the early 1990's and has grown steadily since then. Recent studies indicate that about three out of

four new swimming pool installations are equipped with salt water generators.

There are a number of benefits of a salt water generator. One of the main benefits is on-site generation of sodium hypochlorite rather than adding tablets or liquids to the swimming pool. By using the salt water generator the need of handling some chemicals that are potentially harmful is removed. This use of salt in a salt water generator will greatly reduce strong chemical odors associated with chlorine that are generally present after treatment of pool water and is compatible with most existing pool chemicals

A second benefit is the constant level of hypochlorous acid present in the water. The on-site generators make a weak sodium hypochlorite solution, in the range of six to twenty parts per million. Most cell manufacturers have salt concentration indicators that allow the pool owner to maintain appropriate levels of salt in the pool and by association the level of hypochlorous acid or free chlorine in the pool is also constant. This virtually eliminates the need of shocking an existing swimming pool and avoids the fluctuation of free chlorine levels that are seen with conventionally maintained swimming pools.

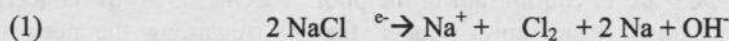
Moreover, there is a positive benefit in the impact that salt has on the swimmer's skin.

Anecdotal observations, but significant none the less is the common comment of the swimmer as to the softness of the water in a salt water pool. There are a number of thoughts for this observation. The primary reason is due to the concentration of salt in a salt water pool; which is between 3000 and 4000 parts per million. This concentration compares to 9000 parts per million in human tears and 35000 parts per million in sea water. Most people can begin to taste salt at 3500 parts per million. An explanation of the observation of softness is the similarity to the level of sodium in the human body.

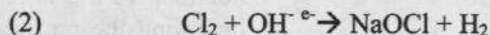
How Does It Work

When pool water passes through a chlorine generator cell, the salt in the water is turned into sodium hypochlorite which then becomes hypochlorous acid. Hypochlorous acid is the exact same component that is produced when any chlorine is added to pool water, whether it is sticks, tablets, granular or liquid. As the water from the generator cell returns to the pool, it will introduce the newly produced chlorine to the body of water to kill algae, bacteria and other micro-organisms, creating a more sanitary swimming environment for you and your family.

By passing the salted pool water through an electrolysis cell, the following reactions take place at the electrodes:



Subsequently, chlorine and hydroxide react to form hypochlorite:



Finally, hypochlorous acid is formed which will do the disinfectant work in the pool.

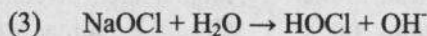
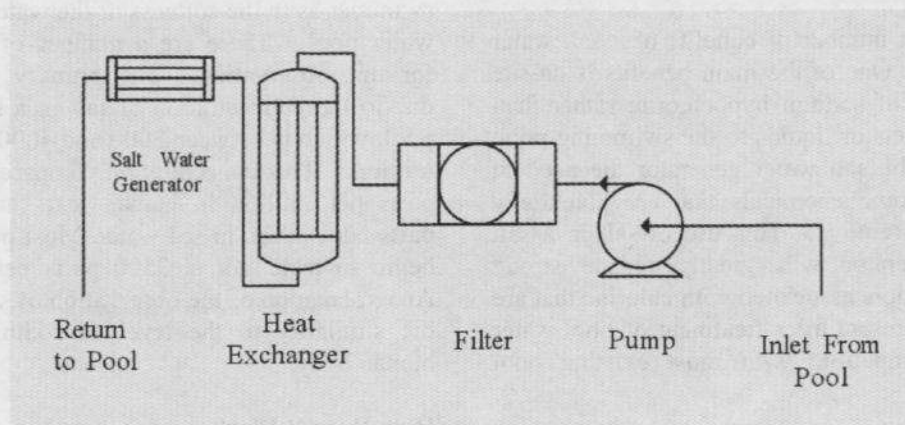
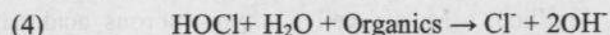


Figure 1 shows a typical layout of a salt water generator in a swimming pool application



After the hypochlorous acid is generated it returns to the pool to (oxidize) organic matter in

the swimming pool. A typical reaction would be as follows:



The benefit of the salt water chlorinator becomes apparent in the reaction listed previously. Salt in water is passed through an electrically charged cell that generates sodium hypochlorite that reduces to hypochlorous acid. When organic matter comes in contact with hypochlorous acid, salt is generated as a result of the reaction which keeps the salt level in balance. The salt is then consumed in subsequent passes through the electrical cell. As a point of distinction, it should be noted that HOCl and OCl⁻ are in equilibrium in the pool, with OCl⁻ being considerably weaker than hypochlorous acid. Therefore, when we talk about the reaction of chlorine with bacteria or organics we usually point to HOCl.

Unfortunately, the system is not self sufficient and will require the addition of further salt. There are a number of factors that lead to the loss of free chlorine from a swimming pool; direct sunlight, rainwater dilution and filter backwashing. As a result of these losses, additional salt must be added to compensate when the electrical cell indicates that more salt needs to be added. The loss of free chlorine to sunlight can be mitigated with the addition of a stabilizer, the most common of which is cyanuric acid. Cyanuric acid forms a weak

“bond” with the free chlorine in the pool water, effectively protecting it from the sun’s UV rays. The loss of salt due to backwash of the filter and rainwater dilution is a loss and must be replaced. The point of this discussion is to show that adding a salt water generator does not remove the need for balanced pool water.

Some caveats

One area of concern was expressed above regarding the need for balanced pool water. The fact that a salt water generator reduces the maintenance level on a swimming pool; it does not remove the need for careful consideration regarding the profile of the water in the pool. The salt water generator will reduce the maintenance but will not remove it.

Another area of concern is application of the salt to the pool, as water in the pool and lining of the pool will contain residual oxidizer in the form of hypochlorous acid, salt contact with the pool lining should be minimized. The oxidizer in the pool will convert any metal such as iron or manganese to their oxide form which can stain pools. It is for this reason that it is best to minimize the time that undissolved salt contacts the bottom of a pool. Many salts

have some residual amounts of iron and manganese which when coupled with extended contact time on the bottom of a swimming pool can create stains to the lining in the form of oxides as mentioned above. Larger salt crystals increase the contact time due to slower dissolution rate. This makes the choice of salt for salt water generator applications critical.

As equation (4) above shows, as the disinfection progress in the swimming pool, hydroxide ions are created as noted by the OH^- at the end of the equation. This indicates that over time the pH of the pool will increase as the hydroxide ions increase in the water. This may not be noticed with a maintained pool, but it does occur over time. However, if the pH is

The final topic deals with the salt that is used to supply the salt water generator. There are three basic categories. The first is rock salt which is an unrefined salt that is mined from existing salt deposits. Most cell manufacturers do not recommend the use of rock salt with their systems due to high levels of insoluble matter and impurities. The next salt is solar salt, which can contain levels of organic matter that cause problems when coming in contact with free chlorine, as a green coloration will often occur. The final form is evaporated salt which is the purest and cleanest of all of the types of salt. Often having less than 0.15% of impurities in the salt and as a result is very white, and safest possible for use in a pool.

Other issues from the cell manufactures are the avoidance of additives. The internal surfaces of the salt water generator cells are very harsh, both in heat and pH; as a result, most cell manufacturers recommend no salt with sodium ferrocyanide as an anti-caking agent. As stated above the salt with elevated levels of iron or manganese should be avoided.

There are a number of salt based additive systems currently on the market. These systems add multiple chemicals to the pool to balance more than the disinfectant level. Each product brings advantages to the consumer with ease of maintenance and can be used in lieu of salt only, but the consumer should determine which approach is the best fit for their pool, chemistry, and lifestyle.

adjusted with muriatic acid (hydrochloric acid) salt will be formed as a result, which will help maintain the salt balance.

A more controversial issue deals with damage to the stones that are used to landscape around a pool. There have been articles published blaming salt for damage to the stones surrounding a pool. The current theory is there are softer landscaping stones that are being used that are more susceptible to scaling from the pool water. Although nothing definite has been determined research is ongoing.

Which Type of Salt Is Best

In summary, a salt water pool offers less maintenance, less chance of a chlorine smell as you approach a pool and simpler chemical control, but its successful usage is dependant on salt choices and addition approach.