



THE HISTORY OF CHLORINE...

Chlorine was first discovered in the sixteenth century, and today is one of the most produced chemicals in the US, finding its way into a multitude of products. Chlorine is so deeply inter-twined into industry that finding alternatives would indeed change our daily lives.



HOW IS CHLORINE MADE...

Chlorine is produced the electrolysis of salt water. When electricity is passed through 2NaCl (salt) and $2\text{H}_2\text{O}$ (water), the atoms dissociate into Cl_2 (chlorine) + 2NaOH (sodium Hydroxide) + H_2 (Hydrogen). Cl_2 is isolated in its gaseous form, and used to create other chlorine compounds used for sanitizing, bleaching and production of plastics and related products.



HOW DOES CHLORINE WORK TO SANITIZE...

When chlorine is added to water, another dissociation occurs. When we add Cl_2 (chlorine) + H_2O (water), we get a reaction which leaves us with HOCl (hypochlorous acid) + HCl (hydrochloric acid). Hypochlorous acid is the active, killing form of chlorine. This is what does the real sanitizing work. The chlorine molecule or ion kills micro organisms by slashing through the cell walls and destroying the inner enzymes, structures and processes. When this occurs, the cell has been deactivated, or oxidized. The hypochlorous molecule continues this slash & burn until it combines with a nitrogen or ammonia compound, becoming chloramines, or it is broken down into its component atoms, becoming de-activated itself.



IS CHLORINE DANGEROUS, UNSAFE OR UNHEALTHY?

No doubt about it, chlorine certainly is a hazardous product, with some forms of it being more dangerous for the handler and the environment than other forms. Chlorine in a solution of water at levels found in swimming pools pose no danger for swimmers. Allergic reactions to chlorine are rare, however some individuals may experience skin irritation. Chloramines, sometimes found in poorly balanced water, are the cause of occasional red eyes when swimming. Extremely high levels of chlorine in the water could possibly release enough gas off of the surface in certain conditions to render breathing difficulties.

The main hazard is towards the person in charge of adding the chlorine to the pool. Use caution and always read the directions. Always use care when opening a container of chlorine. Breathing in chlorine gas can knock you right out, and could be fatal. Always wear protective handling gear such as eye protection and rubber gloves. If chlorine touches your skin, you should wash it off to prevent irritation. If chlorine splashes in the eye, irrigate with water and contact a physician straight away. The label on the chlorine container will also tell you never, never, never mix chlorine with any other chemical. You could produce something of a bomb or even napalm. This includes mixing two different types of chlorine, or chlorine and bromine. KABOOM! Dirt, debris or any foreign substance (algaeicides, alkalis and acids, etc.) can cause spontaneous combustion when mixed with chlorine. FIRE! See our page on [Chemical Safety](#) for more info.

As for the environment; pools have a small impact. Being closed systems, pools just don't contact nature very much. There could be some hazard involved with waste water from the pool that has either extremely high chlorine levels or extremely low pH levels. It is unlikely that the amount of water expelled during backwashing your filter could pose much harm, but large amounts of DE Powder can choke a stream if pumped directly into it. Impacts have been seen on drain and clean jobs, when acid water is pumped into nearby streams. Pool water is very similar in make up to the city water right out of the tap. Many people water their lawns with higher chlorine and lower pH than is found in their pool. There are certain industrial uses of chlorine chemistry, which are detrimental to the environment, but in a swimming pool environment, the potential hazards are much lower, even non-existent. There

has been much publicity and controversy over chlorine in recent years, with some organizations calling for bans on its use. You decide if chlorine chemistry is right for you and your pool.



WHAT DIFFERENT TYPES OF CHLORINE ARE THERE...

In its elemental state, chlorine exists as a gas. Gas is available for swimming pool sanitation; is very cheap, and is the purest form of chlorine, with no binders or carriers. The % of available chlorine is 100%. It is also extremely dangerous and restricted in its use. It is rare to find a pool using gas as it's sanitizer, and those that do are usually very old, very large public pools that have (we hope) enacted strict safety procedures. Gas is very acidic, with a pH close to muriatic acid, so these pools using it add a lot of base to counteract this.

Liquid chlorine is another type which is created by bubbling the chlorine gas through a solution of caustic soda. The yellow liquid (stronger, but chemically identical to bleach) has 10-15% available chlorine, and has a pH on the other end of the scale at 13. Liquid Chlorine is called Sodium Hypochlorite (NaOCl) and because it is already in solution, sodium hypo produces hypochlorous acid instantly when it contacts water. The liquid can be poured directly into the pool, but it is recommended to use a diaphragm or peristaltic pump. The use of liquid chlorine is more dominant in larger commercial pools which have it delivered into 55 gallon vats. For most residential pools, its lower cost seems to be outweighed by its difficulty in use and the amount of acid required to counteract its pH of 13. Use care when handling as this chemical is corrosive to just about everything.

Trichlor is a tablet form of chlorine, and is short for Trichloro-s-triazinetriene, a stabilized form of chlorine that has achieved a great amount of use in the last ten years. "Stabilized" means that it has Cyanuric acid pressed into the tablet. Cyanuric, also called stabilizer or conditioner, is like sunscreen for the chlorine molecule; an extender, if you will. Trichlor is created by combining the salts of Cyanuric acid and chlorine gas into a tablet or stick, and is 90% available chlorine. The pH is somewhat low at 3, so the pH in your pool may gravitate downward. This form is slow dissolving, and so it works well in floaters or in-line erosion feeders. Using tablets in the skimmer is not recommended, because of the corrosive nature of the chemical contacting metal pipes and equipment. This becomes more of a problem when the filter pump is operated on a timer. It has been known to strip out the copper inside of a heater. (An effective, yet expensive means of controlling [algae](#)). Tablets should also not be thrown directly into the pool, they can stain and etch plaster and bleach and deteriorate vinyl.

Another member of the chlorinated iso-cyanurate family is Dichlor, short for Sodium Dichloro -s-triazinetriene. Dichlor is made in roughly the same manner as Trichlor, however the product is much different. The pH is a very acceptable 7, and it is manufactured in the form of granules, so it dissolves rapidly and goes right to work on contaminants. Dichlor has less chlorine, pound per pound at only 62% available chlorine. Because it contains Cyanuric acid, it lasts longer than other unstabilised forms of granular chlorine. It can be used as a shock treatment oxidizer, or for normal sanitation. Dichlor's main drawback is its cost per pound of available chlorine. It is perhaps the most expensive form of chlorine available.

There are two other types of granular chlorine on the market - the hypochlorites. Lithium Hypochlorite, like Dichlor, is a very expensive product. At only 35% available, it takes almost 3 lbs of lithium to equal one lb of Trichlor and its pH of 11 will require additions of an acid to adjust the pool water. Its main advantages are that it is calcium free, and so it won't contribute to hardness levels; it's dust free and non-flammable. It dissolves extremely quickly, before it hits the floor, so its use is safe in vinyl liner pools. Lithium can be used for either shock treating or for regular chlorination.

Calcium Hypochlorite is commonly available in its granular form, but can also be purchased in tablet form. Cal Hypo is a commonly used shock treatment throughout the country. Although not stabilized with Cyanuric acid, it has a quick kill rate against algae and chloramines, and has 65% available

chlorine per lb. Some other granular forms of chlorine are more powder like, and thus dissolve more rapidly than the larger granules of cal hypo. It's a good idea to pre dissolve cal hypo into a bucket of water prior to adding it to a pool. It's popularity is due mainly to its availability and low price, despite a high pH value of nearly 12, and the calcium binders used which contribute to higher hardness levels. Cal hypo is more dangerous and unstable than other forms in that it is very dusty and becomes contaminated easily by foreign substances, which can cause combustion. Mix only with water, don't breathe the dust, and keep the lid tightly secure and clean.



HOW MUCH CHLORINE SHOULD I ADD...

We can't tell you how many tablets or how many pounds or gallons you'll need for your particular pool, but your test kit will. Each pool has its own chlorine demand, the amount of chlorine needed to destroy contaminants that are present. And each pool also has a different capacity, or gallonage. Other factors, such as the water balance, and particularly pH, have an effect on how much chlorine you'll use. Most health departments will close down a public pool that does not have a minimum of 1.0 ppm of free chlorine available in the water during a health inspection. With a little experimentation, you'll be able to determine how many tablets, for instance, it takes to achieve a consistent minimum level of 1.0 ppm. For example, test the water, then add three tablets into your feeder. Check the residual in 12-24 hours. If it's too low, add more; too high, remove some. Fairly soon you will develop an idea of your pool's particular chlorine demand, however, this will change during warmer months and periods of increased use, among other things. Chlorine is an expensive and corrosive compound, so make the attempt to avoid consistently over chlorinating the pool, which may also irritate your swimmers.



WHAT AFFECT DOES pH HAVE ON MY CHLORINE...

The efficacy of chlorine, that is, the power of it to have an effect, is greatly influenced by the care with which you manage your pH levels. As the pH of your pool increases, the killing power of your chlorine decreases. At a pH of 6.0, we'll get 96% or so of the potential out of each lb of chlorine, but at what cost? Such a low pH would wreck havoc on all of the surfaces the water comes in contact with, including swimmers. It's just too corrosive. Move the pH up to 7.0 and the efficacy of the chlorine drops to 73%, but raise it up to 8.0, where many a pool seems to drift to, and it drops dramatically...down to 21%! At a perfect pH level of 7.5, we can expect to have about 50% of our chlorine in the molecular structure of hypochlorous acid, the active, killing form. The remaining half is in the form of a hypochlorite ion, which is also an active form of chlorine, but very weak and slow to kill.



WHAT IS TOTAL, COMBINED AND FREE CHLORINE...

These are states of existence for the chlorine molecule. If a molecule is free, it has not bonded with or *combined* with another compound. It is therefore available for sanitizing. When free chlorine molecules encounter and destroy a nitrogen or ammonia containing compound, they combine with them to create a combined chlorine compound, or a *chloramine*. The chloramine is no longer available to sanitize anything, and it floats around in the water, blocking the path of those do-gooder free chlorine molecules, and stinkin' the place up! If you smell a strong aroma of chlorine in and around a pool, chances are it has high combined chlorine levels. This level can also be tested with a DPD test kit which measures total and free levels separately and allows the tester to determine combined levels by subtracting the two. Total chlorine is simply the sum of combined and free levels.



WHAT IS SHOCKING OR SUPERCHLORINATING...

These are synonymous terms for oxidizing everything in the pool. By raising chlorine levels ten times the level of chloramines, a threshold is reached called *breakpoint chlorination*. When this is reached, something of a *shock*, or perhaps more akin to a lightning bolt, rips through the water, slashing and burning everything in its path.

When to shock? Some recommend shocking the pool when combined chlorine levels reach .3 ppm, while others suggest shocking after a party full of kids get out of the pool :-) (the theory here is that kids=urine = nitrogen + chlorine = chloramines). Others recommend it once every few weeks, whether it needs it or not. You may use your senses to determine the need for shocking. If the pool is hazy, because *somebody* left the filter off or forgot to add chlorine, your eyes may tell you it's time to shock. If you notice a strong chlorine smell to the water, and the eyes are burning, you may sense the need for shocking. Large doses of chlorine, in the way of shocking, are also very effective when algae has turned the water or walls a yellow or green color.

How much chlorine is required to shock? Generally, we want to raise the chlorine level up to around 10 ppm. If using cal hypo, you'll find that at least one bag per 10,000 gallons will do the trick. A little more wouldn't hurt, because if you don't reach the crucial level of breakpoint chlorination, not only is the chloramine problem not solved, but matters have been made potentially worse. Follow instructions on the package of granular chlorine shock or non-chlorine [shock](#), which may be potassium peroxymonosulfate. Liquid chlorine can also be used for superchlorination. Whatever chemical, we must introduce 10 times the potential of the chloramines. For example, if combined chlorine levels are at 1.0 ppm, we need 10 ppm of free chlorine levels to reach breakpoint.



WHAT ABOUT STABILIZER...

Cyanuric acid is a chlorine stabilizer, providing a chemical cloak around the chlorine molecule which protects it from the sun's UV radiation, the largest killer of your chlorine. It can be a real money saver, that cyanuric, especially during the hottest times of the year. A test kit can measure how much cyanuric acid is present in the water. Recommended levels from the [National Spa & Pool Institute](#) are at 30-50 ppm. The stabilizer (also called conditioner) is fed directly into the skimmer at a rate of 4 lbs per 10,000 gallons. It dissolves inside the filter and you will immediately see a reduction in your chlorine demand. If you are using chlorine from the iso-cyanurate family, the cyanuric acid is already present in the tablet and you shouldn't need to add any additional, unless the level is below 30-50 ppm.