New Zealand Pool Industyr Association Incorporated, PO Box 17069 Greenlane 1546 email executive@poolguild.org.nz

PAPER 5
SWIMMING POOL CHEMICAL TYPES & USES

INTRODUCTION

This PAPER examines at the types of Chemicals or Chemical alternatives available within the main categories of disinfection of residential swimming pool water and discusses the use of each.

Trade Name Chemical names commonly used (i.e. CAL HYPO for granular Chlorine aka Calcium Hypochlorite) have been used wherever possible to simplify the identification of these products and to avoid favouring any particular brand. In some cases, however, the chemical may be known only its commercial name. The universal chemical used as this is written (June 2021) is Chlorine in many forms like “Granular”, “Liquid”, “Tablets”, “Salt Generated” and so on.

So we will start with this popular Product:

CHLORINE AND CHEMICALLY RELATED PRODUCTS

CHLORINE

Chlorine is a member of the Halogen family, some of which will be very familiar to you.

The halogen family consists of the elements: Fluorine, F; Chlorine, Cl; Bromine, Br; Iodine, I; and Astatine, At. All the halogen elements except Astatine exist in the Earth's crust and atmosphere.

Although all halogens generally undergo the same types of reactions, the extent and ease with which these reactions occur vary markedly. Fluorine in particular has the usual tendency of the lightest member of a family of elements to exhibit reactions not comparable to the other members. Each halogen must be considered individually, both in its preparation and in its reaction.

The commonly used Halogens in swimming pools and spa pools are, of course, Chlorine & bromine. You may recall Iodine being used on cuts as a child, while Astatine is generally only of use to the medical profession – being used as a physiological trace medium.

Maintaining a pool in good condition in a chlorinated swimming pool starts with the chemical treatment of the water. The purpose is to keep it free of bacteria and to prevent the growth of algae by maintaining a CHLORINE RESIDUAL.

This term descibes the total amount of FREE CHLORINE that is 'over and above' the BREAK-EVEN POINT, so is often referred to as BREAKPOINT CHLORINATION.

Chlorine has been the most popular and effective chemical for this purpose up to date because it disinfects, as well as destroying algae, and it has a speedy kill rate providing Chlorine-based chemicals are used at the right levels. Bromine useage is generally restricted to spa pools, as the slow-dissolving rate makes it suitable for prolonged sterilization in hot water.

(More recently, Ozone has become more widespread, especially with the rapid growth of spa pools over the last decade using UV – ultraviolet - Ozone almost exclusively. Swimming pool UV Ozone devices are also coming into more use as people are becoming wary of excessive dangerous chemical use and un-environmental activites.) More about Ozone later in this Paper.

Chlorine is available in granular form, liquid form and in compressed tablets. These compounds dissolve when added to water, releasing Chlorine gas. Chlorine supplied as a gas in cylinders is not used in home pools as it requires special storage due to its toxicity, and the need for speciallised injection equipment.

Commercial interests have introduced a large variety of Chlorine products on the market under a wide range of brand names, however, these products can be narrowed down to the four (4) main compounds, namely Sodium Hypochlorite, Calcium Hypochlorite, Sodium DiChloriso-cyanurate (DiChlor), and Sodium trichloro-s-triazinetrione (trichlor). Refer to the fine print on the label of the Chlorine product to find out what active ingredient it contains.

DICHLORINE

(aka = also known as) **DiChlor** is the only packaged **Chlorine** form suited for spas because although it is a little more expensive, it has near-neutral pH and does not require the addition of Cyanuric Acid stabilizer. ... It is best to dissolve **DiChlor** in a bucket of clean water first, then add to spa water. Short for DiChloro-S- Triazinetrione, DICHLOR is one type of **Chlorine** available for keeping pool water clean. Similar to **trichlor**, a different kind of **Chlorine**, **DiChlor** is usually granular but can also be found in tablets. You can buy **DiChlor** in bags or in bulk.

See SODIUM DISCHLORISOCYANURATE (Below)

CALCIUM HYPOCHLORITE

Calcium Hypochlorite (granular & tablet Chlorine) would undoubtedly be the most popular form of Chlorine in use today and has an available Chlorine content ***of 65 per cent***. It is economical and has a reasonable shelf life if properly stored. The granular form has been used successfully by pool owners for many years.

The necessary quantity may be measured out, mixed in a bucket of warm water, and added to the pool through the skimmer (although there is dissention over this method).

Adding the mixture straight into the pool is not advised, as these days there are a great meny pool types that may be damaged or discoloured by the tiny speck of Chlorine that dis not dissolve completely in the warm water.

When used in this manner, it quickly dissolves, releasing its Chlorine and is dissapted throughout the pool via the pool water return, enabling the Chlorine level of the pool to be quickly restored if it has been allowed to fall below a recommended level.

Some brands of Calcium Hypochlorite will leave a considerable residue if sprinkled directly into the pool which must be immediately removed or spread out by rapid brushing – and and may lead eventually to the formation of a Calcium scale on the floor and walls of the pool.

In the past, mixing the required quantity of Cal Hypo in a bucket of water and allowing it to stand for half an hour, after which the liquid was poured into the pool and the Calcium residue discarded, defeats current thinking that a higher Calcium level in the pool is desirable. (300 to 400ppm 300 mg/l in cement pools, 200ppm - 200 mg/l - in fibreglass and vinyl liner pools) but the potential of damage to the pool finish is not worth the risk comnpared to adding through the skimmer.

Calcium Hypochlorite is also available in tablet form, which are generally used in the cheaper above-ground pools. The required number of tablets are placed in a floating dispenser, which is then allowed to float around the surface, releasing Chlorine as it goes. Problems may arise if the dispensed is upended and the tablets tip out and end up on the pool floor – potentially a bleaching issue may follow.

The use of tablets also appears to considerably reduce the problem of residue, but generally wear out quite quickly.

Calcium Hypochlorite can be used to super-chlorinate the pool but has poor ultra-violet light stability, the available Chlorine being quickly dissipated into the atmosphere.

SODIUM HYPOCHLORITE

Sodium Hypochlorite is a liquid form of Chlorine which is relatively low-cost and easy to administer – as it may be poured directly into the pool from the container, and mixes readily with the pool water, leaving no residue.

The available Chlorine content, however, ***is only about 10% to 12%,*** and this necessitates the storage and handling of a larger volume of chemical. For this reason, it is generally unpopular with inground swiiming pool owners.

However, being a liquid, Sodium Hypochlorite is ideal for use with the many types of automatic Chlorine dispensers which are now available. Because of its ability to release its Chlorine quickly, it is also very useful for super-chlorination and shock treatment of algae. It will give a very high Chlorine reading, leave no residue, and will dissipate quickly.

Sodium Hypochlorite has poor ultra-violet light stability but is safer to store than other Chlorine compounds. It is an unstable product which loses its effectiveness fairly rapidly, i.e., a very short shelf-life (4 to 8 weeks) compared with dry Chlorine-based chemicals, so for this reason it should not be purchased in large quantities.

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SODIUM DICHLOROISOCYANURATE (DICHLOR - DiChloro-S-Triazinetrione)

Pronounce it: "DI-CHLORO-ISO-CYAN-U-RATE" or DICHLOR for short. Why do we need DiChlor?
The two Chlorine compounds discussed earlier; Sodium Hypochlorite and Calcium Hypochlorite, have one common fault - the available Chlorine produced when dispersed in a pool is quickly dissipated by the reaction to sunlight, meaning that much of the Chlorine's power is wasted, and therefore the Chlorine demand becomes excessive.

There is also the danger that the Chlorine level will drop to a point where it ceases to destroy bacteria introduced by swimmers. This means that pool owners constantly have to monitor and adjust their pool's Chlorine levels to ensure the water is safe for swimming.

This may be overcome by the addition of a Chlorine stabiliser. The stabiliser used is Cyanuric Acid (1,3,5-triazine-2,4,6-triol), which ***acts as an ultra-violet filter*** or screening agent. It can be added to the pool either in concentrated or in the form of a chlorinated cyanurate compound such as Sodium DiChlorisocyanurate, or DiChlor.

Available in granular form, Sodium DiChlor contains ***about 63 per cent*** available Chlorine, together with a small amount of Cyanuric Acid. If used regularly over a period, the Cyanuric Acid builds up to a point where it forms an effective screen against the ultra-violet rays of the sun. In this way, Chlorine loss due to sunlight is greatly reduced. Sodium DiChlor is added to the pool by sprinkling around the edges, but unlike Calcium Hypochlorite, does not leave a residue. It is somewhat more expensive than Calcium Hypochlorite, but as it is stabilised Chlorine, smaller quantities are needed. Sodium DiChlor is also available in tablet form which can be added to a floating dispenser.

If Sodium DiChlor is used over a prolonged period, however, a new problem arises.

Cyanuric Acid will not disperse in the same manner as Chlorine, and its level will continually rise.
As well as acting as an ultra-violet filter, it also retards the speed at which the Chlorine kills algae and bacteria If the level is allowed to increase indefinitely, the stage will be reached where the Chlorine will have little or no effect on Algae, or more importantly, on Bacteria.

Thus, this will imply that the continued use of Sodium DiChlor will eventually defeat its own purpose. The level of Cyanuric Acid (tested by a special test kit) should be maintained between 30 to 50, but not more than 100 mg/l.

This may be achieved by alternating month by month between Sodium DiChlor and Calcium Hypochlorite.
Alternatively, a container of DiChlor - say 4 kg - may be purchased. When this is finished, a 10 kg container of Calcium Hypochlorite would be used. By alternating in this manner, the small quantity of Cyanuric Acid lost through splashing, backwashing, etc., is replaced without the level becoming excessively high.

It should be emphasised, however, that these two chemicals, Calcium Hypochlorite and Sodium DiChlor, should never be mixed. They must always be used separately, or combustion may occur. (i.e. Fire)

Due to the build-up of Cyanuric Acid, Sodium dichor is not recommended in super-chlorinating the pool. It has a good shelf storage life.

Rainfall and water top-ups in summer help to keep the Cyanuric Acid levels down, but if the recommended levels are exceeded, the only recourse is to pump the pool down by 50% volume, and refill with fresh water.

SODIUM TRICHLORO-S-TRIAZINETRIONE (aka TRICHLOR)

A further Chlorine compound (pronounced) TRI-CHLORO-S-TRI-AZ-INET-TRIONE generally referred to as TriChlor and packaged in tablet form which contain about ***90 per cent*** available Chlorine together with Cyanuric Acid as a stabiliser.

Trichlor tablets dissolve slowly, and when used in a floating dispenser will continue to release Chlorine for several days, thus eliminating the need for daily dosage. In all other respects trichlor may be regarded as being similar to DiChlor and should be used in the same manner.

Never, Never throw the tablets directly into a Fibreglass or Vinyl-Liner pool, as prolonged direct contact with the pool floor, pool liner or pool walls can cause discolouration or other damage. Equally, using them in the skimmer basket can cause problems in the filtration system due to the low pH of 2.0 to 3.0 (i.e. very Acidic)

CYANURIC ACID (CYA)

Cyanuric Acid is NOT AN ACID: Despite the confusing name, Cyanuric Acid is not “Acidic”. The addition of Cyanuric Acid forms a water-level layer that filters Sunlight (thus saving the Chlorine), and does not affect the pH and, therefore, should not be confused with Acids such as Hydrochloric Acid (aka Muriatic Acid), which does reduce the pH. It will, howver, add to the Total Alkalinity count.

As an alternative to using Sodium DiChlor, the pool may be stabilised by the addition of Cyanuric Acid in its pure form. This is normally packaged as a powder and is often labelled 'Pool Stabilizer' or 'Pool Conditioner'. Cyanuric Acid will form a layer at the pool surface and inhbit sunlight from depleteing the Chlorine levels in the pool.

As it is rather slow to dissolve, it is preferable to first mix it in a bucket of water. The mixture should then be added through the pool skimmer preferably at night – of course, with the circulation running all the time to ensure that the chemical has dissolved by morning. As the powder may remain for some time in the filter media, don’t backwash the filter for at least 24 hours of running.

In addition to stabilising available Chlorine and buffering pool water, the Cyanuric Acid/Cyanurate system contributes to total alkalinity since this is the sum of all titratable alkaline substances and cyanurate is a titratable alkaline substance (i.e. they loose protons in an acidic situation). Therefore, the total alkalinity titration measures both carbonate and cyanurate alkalinities. This affects water balance calculations because the alkalinity term in the Saturation Index equation is strictly carbonate alkalinity

Adding stabiliser is normally carried out when the pool is first filled, and again at the start of each season, as rain, top-ups etc. have diluted the stabiliser product. The initial dosage should be approximately 30 mg/L. After a pool has been stabilised in this manner, Calcium Hypochlorite or Sodium Hypochlorite is used in the normal way.

Preferences: .There is considerable argument among pool owners as to the best method of stabilising and chlorinating a pool. Some prefer to use Cyanuric Acid and a Hypochlorite. Others insist that the alternating method, DiChlor then Hypochlorite, is the only one worth using. As the result is the same in either case, and the cost appears to be similar, it becomes a matter of personal choice.

Regardless of the method used, care must be taken to maintain the Cyanuric Acid level within the range of 30-60 mg/L. Below 30 mg/L, there is insufficient Cyanuric to prevent the loss of Chlorine. Above 50 mg/L, the effectiveness of the Chlorine is impaired, but can be compensated up to 100 mg/L by increasing the free Chlorine level to 3 mg/L as a minimum level. The level of Cyanuric Acid may be easily determined by means of a simple test kit.

Reduction in CYA levels is generally only possible by dumping/adding water to the pool.

QUANTITIES TO BE USED

Most manufacturers publish recommendations as to suitable quantities, both on their labels, and in their advertising literature. These recommendations often vary considerably.

It must be remembered, however, that any published recommendation should be taken only as a guide - a starting point on which a pool owner may base his own experiments to determine the needs of his own individual pool

NOTE:

THE DOSAGE FIGURES ARE BASED ON AVERAGE WATER AND POOL CONDITIONS AND DO NOT TAKE INTO ACCOUNT SUCH FACTORS AS HEAVY USAGE, SEVERE RAIN AND WIND STORMS, ETC.

SUCH OCCURRENCES CAN AFFECT THE CHLORINE RESIDUALS AND PH LEVELS OF POOL WATER QUITE CONSIDERABLY.

DOSAGE GUIDE FOR CALCIUM HYPOCHLORITE AFTER CYANURIC ACID STABILIZER HAS BEEN ADDED TO THE POOL AT THE BEGINNING OF THE SWIMMING SEASON

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CALCIUM HYPOCHLORITE DOSAGE

Capacity Kl	New Pool	Add Stabiliser 12 Hrs later	Every Other Day	Superchlorinate Weekly	Shock Dose Treatment
20	140 g	1 kg	40 g	140 g	280 g
30	210 g	1.5 kg	60 g	210 g	420 g
40	280 g	2 kg	80 g	280 g	560 g
50	350 g	2.5 kg	100 g	350 g	700 g
60	420 g	3 kg	120 g	420 g	840 g
70	490 g	3.5 kg	140 g	490 g	980 g
80	560 g	4 kg	160 g	560 g	1120 g
90	630 g	4.5 kg	180 g	630 g	1260 g
100	700 g	5 kg	200 g	700 g	1400 g

Chlorine is used in pools as a sterilising agent. The amount required, therefore, will naturally depend on the degree of pollution. This will vary according to the number of swimmers using the pool, and the number of wind-blown debris deposited in it. Dust, leaves, grass clippings, perspiration, etc., all increase Chlorine demand. Such factors as sunshine and water temperature are also significant.

The only reliable method of determining Chlorine demand is by regular testing, with a reliable test kit. Dip Strips are useful as a quick comparison (used daily during a balancing session) but the 4-in-1 ond 5-in-1 "Chemistry Sets" are considerably more accurate. NOTE: **Both methods are invalidated by using past-dated reactors or strips**!

Before commencing, it is necessary that the pH be adjusted to the correct level, and in the case of a newly filled pool, the initial treatment to Balance the pool water should be carried out.

In the case of an unstabilsed pool, it is suggested that, as a starting point, a cup of Calcium Hypochlorite (about 280 grams) or about 1 litre of Sodium Hypochlorite, should always be done in the evening, so as to prevent the loss of Chlorine due to sunlight. The following morning a Chlorine test should be carried out. This should show a level in the range of 0.6 to 1.0 mg/L.

If the Chlorine level is below 0.6 mg/L, there is insufficient residual Chlorine to take care of pollutants introduced by swimmers during the day, and additional Chlorine must be added. The quantity added that evening should also be increased accordingly, and the test repeated next morning. On the other hand, if the level is over 1.0 mg/L, the quantity added that evening may be reduced. By repeating this procedure for several days, the normal Chlorine demand of a particular pool may soon be determined. As you gain experience, the frequency of testing may be reduced.

If a pool has been stabilised, it will be found that a smaller quantity of Chlorine is required, usually about half of what is suggested above. However, in the case of a stabilised pool the Chlorine is somewhat slower-acting and more Chlorine has to be available because the Acid slows down the bactericidal action. It is necessary to maintain a higher residual level - about 2 mg/L. If using Sodium DiChlor, the procedure is the same: a cupful every second night being suggested as a starting point.

While the above procedure will determine the normal Chlorine needs of your pool, it is emphasized that regular testing must still be carried out. Demand will vary according to conditions. More Chlorine will be needed, for example, during hot weather. An unusually large number of swimmers will increase the Chlorine demand, and more must be added. Similarly, additional Chlorine will be required immediately after heavy rain. Such demands can be determined only by proper use of the test kit.(unless the system is fitted with an ORP controlled injection device)

WHAT IS ORP?

O.R.P. stands for Oxygen Reduction Potential (OR ***Oxidiser*** Reduction Potential – depending on who you ask) and is mentioned here because it is the only reliable method for determining the effectiveness of oxidisation in the pool. Every electronic device that automatically takes care of pH & chlorination uses ORP to determine when (and when not) to go into action. Not common in residential pool sheds, it is found in commercial swimming pool installitons.

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NON-CHLORINE SANITIZERS

OZONE
The production of Ozone (Chemical designation O^3) is generated in two basic forms: UV (ultra-Violet Light), and CD (Corona Discharge Light).

UV Light is typically generated in a replaceable fluorescent type tube at a wavelength of between 100 and 254 nm (nm = Newton Meters). At 185 nm "ozone" is produced, while at the upper wavelength "Germicidal: light is created

Ozone is a very powerful and useful Oxidant (far more powerful than Chlorine) - which is why there have been restrictions and controls on its use in Public Swimming pools in some countries. Accordingly, Ozone has an (incorrect) bad reputation in some countries (USA Particularly).

The New Zealand Government Health Department publication "Treatment processes: Disinfection (of potable water)" lists in paragraph 15.2.3 Nature of the Disinfectant the three effective power as:

1st ozone – 2nd Chlorine dioxide – 3rd Chlorine – 4th chloramines (very weak)

https://www.health.govt.nz/system/files/documents/publications/dwg-chapter-15-treatment-processes-disinfection-jun19.pdf

Home swimming pool Ozone generation units designed specifically for home pools are therefore low power devices that are very suitable for this purpose. Unlike Chlorine (which kills only about 65% of bacteria and germs), Ozone will kill 100% of contaminant bacteria and viruses (viri).

Ozone is highly "reactive" (i.e. it will attack other molecules and destroy them) and destroys microorganisms on contact. It is effective against common bacteria found in home pools that Chlorine does not affect, like Cryptosporidium and Guardia, and even Staphylococcus Aureus (aka MRSA) – nasty germs that will make affected children very grumpy and ill for several weeks. (Not unlike Influenza) Even Covid-19 will be destroyed by Ozone.

Technically speaking, Ozone Molecules present in home swimming pool water will attack every other molecule it encounters including Chlorine. So, the two disinfectant systems should never be used at the same time.

Some "Ozone Generation Machines" combine both UV and CD, but both types rely on the generation of ultra-violet light to react with and destroy Oxygen molecules (O^2) by splitting them into unstable O^1 molecules. These molecules will seek out and join up with O2 to for the O3 Ozone molecule. These have a short life-time of between 2 and 5 hours before shedding off the third Atom to become Oxygen again, with the resulting low oxidization level.

The main maintenance for Ozone systems is the periodic replacement of the fluorescent UV tubes, and occasionally the CD Corona electrodes if they can be isolated from the equipment. In some Ozone systems this may require replacement of these components as a package

QUATERNARY AGENTS (aka Quats)

Quaternary ammonium compounds (commonly known as quats or QACs) are cationic surfactants (surface active agents) that combine bactericidal and virucidal (generally only enveloped viruses) activity with good detergency and, therefore, cleaning ability

Competing nowadays with the traditional Hypochlorites and isocyanurates are other products, Quaternary Agents such as Baquacil were released on the New Zealand market in the 1980's. This product does not rely on the release of free Chlorine. Instead, the compound itself is intended to function as a disinfectant. This product reduces the need for pool treatments to around once per week.

Apart from Baquacil, there are several other water treatment products which can be used instead of Chlorine for shock treatment to disinfect and to clear up pools which have become green or clouded through a build-up of algae.

PRISTINE BLUE

PristineBlue (https://www.youtube.com/watch?v=N9VEtPry3AM) is a non-Chlorine chemical system which provides pool owners with many advantages over Chlorine. It's gentle on eyes and skin, won't bleach vinyl liners and your family can swim immediately after application. The formula used to make PristineBlue® is EPA registered in every state and is Certified to NSF/ANSI Standard 60 as a drinking water additive. Pool owners can treat their pool water with the same chemical used to control algae and bacteria in many U.S. drinking water supplies.

PristineBlue® does not dissipate, so it's very cost effective because every drop works against algae and bacteria in your pool or spa. Overall, the cost to maintain a swimming pool on PristineBlue® for one year is about the same or less as running a pool on Chlorine.

There are similar products on the New Zealand market, most using the "BLUE" in the name somewhere.

BAQUACIL/REVACIL

An imported liquid water disinfectant, available in Chemists and other Shops, Baquacil is an organic chemical for disinfecting home swimming pools, which does not bleach and does not break up under sunlight. It is claimed to have no smell and no irritating effects on eyes or skin, to be non-flamable, and not to be Acidic or alkaline, so the pH balance of the water remains stable.

Another interesting property of this product is that it has an inbuilt flocculent, making it easier to keep the pool clean. Because of this flocculent property, D.E. filters must be given more frequent maintenance. The larger dirt particles will block the D.E. filter pads faster, more regular backwashing is necessary as well as frequent manual cleaning of the filter pads by removing them from the tank and hosing off thoroughly. With sand and cartridge filters, the larger particles can be trapped more effectively.

Baquacil is totally incompatible with Chlorine, and these cannot be used together as a brown precipitate will form. Before using it in a pool, you have either to add a neutraliser or leave the water untreated for a few days so that any Chlorine in the water will dissipate.

The normal Chlorine test kit cannot be used with Baquacil, but special test kits are available for this purpose. Water testing is not needed as frequently as with Chlorine products since the pH remains more stable due to the absence of any Acid or alkaline content in Baquacil. However, weekly testing is recommended.

Another product called 'Baquashock' is used on a monthly basis in conjunction with Baquacil as a shock treatment to control algae.

No toxicity information on the active ingredient of Baquacil appears to be available.

Before using Baquacil for the first time, the pool must be tested, using the normal Chlorine test kit to ensure that it is no longer possible to detect the presence of Chlorine. Baquacil may then be safely added to the pool, after first brushing and vacuuming to remove larger particles from the water, and then cleaning the filter. The pH should also be tested and adjusted in the normal manner.

Initially, Baquacil should be added at the rate of 0.5 l/10 kL of pool water to give a concentration of 50 mg/L. Algene should also be added at this time in the proportion of 1 L/10 kL. The filter should now be run continuously for 24 hours, and the pool again brushed and vacuumed. The level of Baquacil should now be checked by means of the special Baquacil test kit to ensure that the level is near the desired 50 mg/L. Lf it appears to be closer to 25 mg/L, a top-up dose of 0.2 L/10 kL should be added. The pool is now ready for use.

Under normal conditions, the average pool will require additional Baquacil approximately fortnightly. However, the level should be tested weekly and topped up if necessary, at the rate of 0.2 L/10 kL. The pH should also be tested and Acid or alkali added as necessary.

Baquashock should be added monthly at the rate of 1 L/10 kL, distributed around the edge of the pool and left to stand overnight, after which the pool may be filtered in the usual way.

In some areas, the mains water will be found to contain a high concentration of Chlorine, which must be neutralised if this water is used for topping up a Baquacil treated pool. This is achieved by adding a quantity of 'starter' crystals to the skimmer box and topping up with water through the skimmer box.

NOTE: Baquacil is an organic pool treatment in the form of a liquid disinfectant and is used once a fortnight, in conjunction with the shock treatment Baquashock.

CHLOROMINES – THAT "CHLORINE SMELL" and SHOCK TREATMENTS to remove them

Contrary to popular myths, it is not the "too much Chlorine in the pool" which produces that strong and familiar smell that causes swimmers' eyes to sting and the pool to "smell of Chlorine".

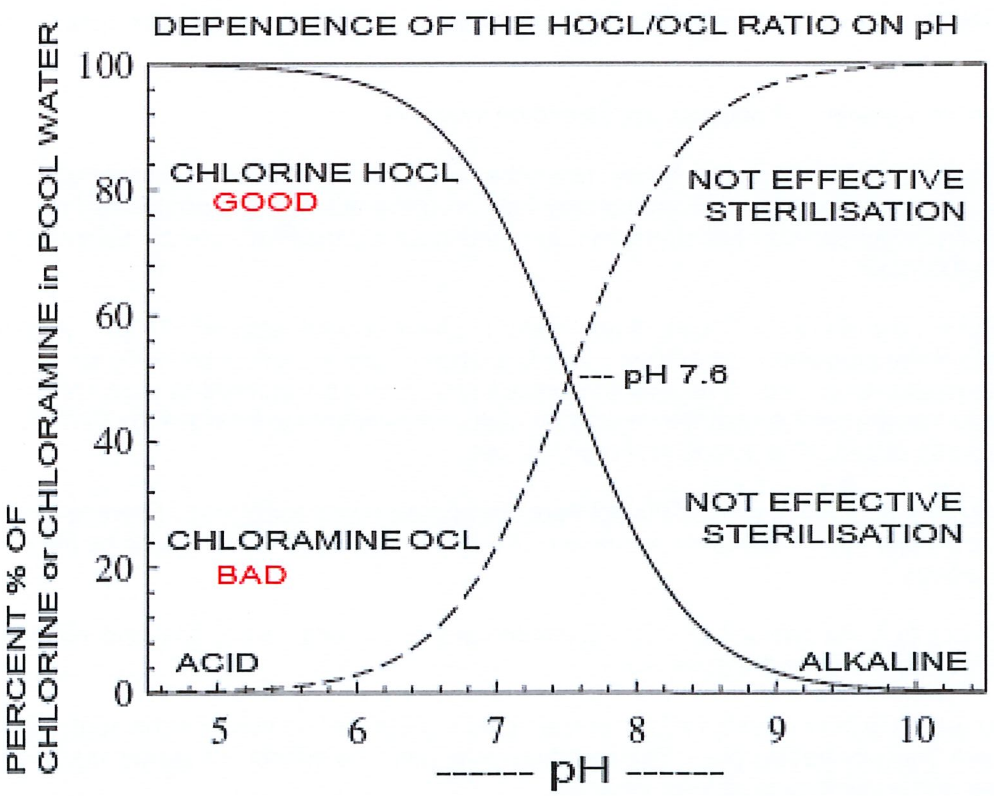
Free Chlorine at the concentrations found in swimming pools is ***both odourless and non-irritant***. The culprit are Chloramines (aka OCL). These have mild sterilisation ability (25,000 less than 'proper' Chlorine HOCL) but are created by the incomplete oxidisation of nitrogenous matter due to insufficient HOCL being poresent in the pool water. The more people that use the pool, the faster will free Chlorine (HOCL) be used, and chloramines (OCL) build up. Most people who smell the 'rotten eggs' smell think it's Chlorine, ... and the Urban Myth continues.

To deal with chloramines, SHOCK TREAMENT is necessary.
YES - MORE CHLORINE MUST BE ADDED TO THE POOL!

Shock treatments are oxidising agents that break down either the organic matter in the pool, or the chloramines already formed by the presence of organic matter, or both. For the several hours that this reaction goes on, the pool should not be used. Some treatments can drastically alter the pH of the water, so check pH and correct it if necessary before swimming is resumed. If you use Sodium or Calcium Hypochlorite in your pool, there is no need to buy a special 'shock treatment' product as an extra-large dose of Hypochlorite will superchlorinate the pool and do the trick.

The chart (below) shows the point at which the "good Chlorine" or HOCL dips below the presence of "bad Chlorine" – chloramines- and not only is the pool sterilization below the required amount to provide safety to the swimmers, but the resulting excess of chloramines will also be noticeably odourous.

Thus: the maintenance of pH at 7.6 is fundamental and should always be the first level to secure before attempting anything else!



Super-chlorinating with Calcium Hypochlorite to maintain a level of free Chlorine of 10mg/L ***may cause the water to go milky for a while*** and may also produce a considerable ***Calcium residue*** which can be vacuumed out. Sodium

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hyochlorite does not produce these effects nor do the non-Chlorine shock treatment chemicals available which we will now discuss.

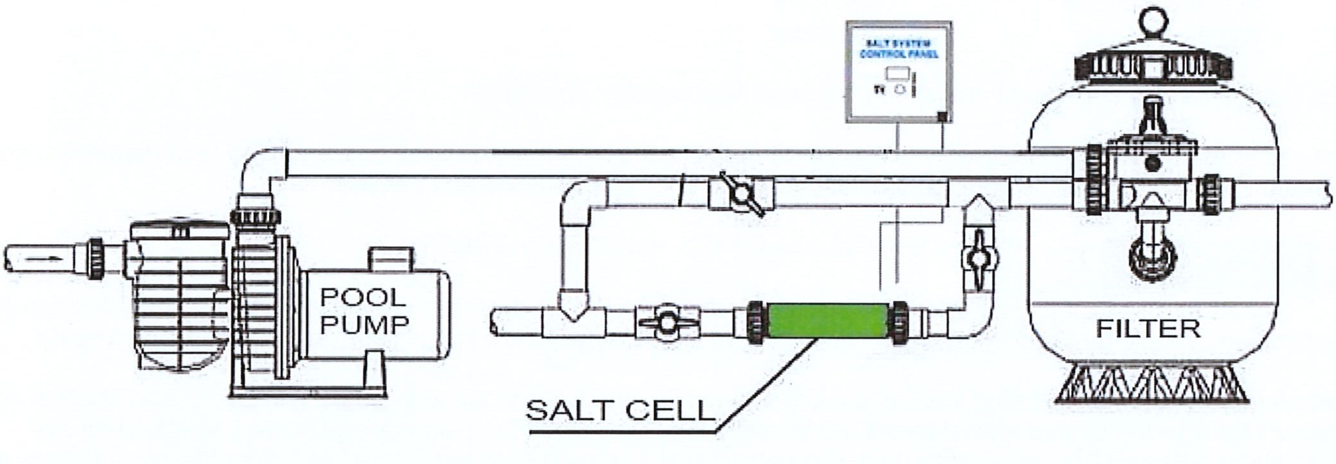
Some are called **Pool Clarifiers** or **Water Polishers,** and most are in liquid form containing a flocculent agent. As mentioned previously, the flocculent agent causes suspended particles to join together, becoming heavier and sinking to the floor where they can be vacuumed out. This "flocking" action clears the pool water very quickly. When this kind of chemical is used to clarify a pool, the filter should be backwashed before and after vacuuming, or alternatively, vacuum to waste and ***definitely*** not through the filter as the filter Media will clog up and need replacing.

For normal use, about 20 mL (Check the label) is added per 5 kL of pool water every three to four weeks. Check that the product is compatible with Chlorine if used as the regular disinfectant.

Another shock treatment which does not contain Chlorine is GLB Oxy-Brite which is a granular compound designed to burn out most of the contaminates that accumulate in the pool such as mucous discharges, urine, oil, leaves and grass. The preparation is compatible with Chlorine. A fortnightly dose of 10g/kL of pool water is recommended after a heavy initial dose.

SALT

The very popular Saline (Salt-water) chlorination involves the use of common salt which is dissolved in the pool to produce a salinity that is about .0003%(*) of the level of sea water which is 3.5% saline. Most **chlorinator** models require 3,500ppm – 7,000ppm (0.35% - 0.7%). Although newer models only require 3,000ppm (0.3%) **salt** to make Chlorine.



Saline pool water flows continuously through the saltwater chlorinator cell unit (from right to left in this illustration) whenever the filter is operating. The actual CELL that generates the Chlorine is shown in GREEN to assist locating it.

A low 12v DC (Direct Current voltage) is applied to to the electrode leafs in the cell container, resulting in the electrolytic breakdown of salt to produce Sodium Hypochlorite (which is a liquid form of Chlorine), plus Sodium hydroxide (caustic soda) and hydrogen gas. The Sodium Hypochlorite purifies the water in the normal way, reacting with the organic matter in the pool and resulting in the formation of salt once again. The whole process is repeated in a continuous cycle while the system is operating.

The presence of Sodium Hydroxide (pH 14) and Sodium Hypochlorite (pH 10–12) will cause the pH to rise, so extra steps must be taken - the addition of Sodium bysulphate (pH 1) or hydrochloric Acid (pH 1) - to ensure the stability of the pH at the recommended level of 7.6. Automatic dosing machines are available to do this automatically, by means of a testing device and peristaltic pump from a container of Acid.

If your customer does not have the automatice peristaltic pump/Acid feed option, it's very likely that you will find a high pH level, as many pools (almost all fibreglass pools are supplied with them these days) are sold with a Salt Chlorinator but no ancillary device to balance the pH. So, a high pH is common, meaning there is virtually no sterilisation taking place once the pH goes over 8.0 (but the pool will "go green" as algae will grow abundantly in a high pH situation, yet the high pH goes unnoticed).

In one U.S. study when the **pH** was lowered from 6.6 to 5.0, **algal** abundance increased (Prof. Peter R Leavitt 1999). Because an **increase** in **algal** abundance was observed when lowering the **pH**, it can be expected that **algal** abundance should decrease when the **pH** is raised. (*)

The amount of liquid Chlorine produced by a Saline Electrolyisis system is dependent on the poswer out put of the unit, the salt concentration in the water and the length of time the filter and chlorinator operate.

A washed clean salt is marketed in 25 kg bags usually, through swimming pool supply store. When a saltwater chlorinator is installed for the first time, salt is added to the pool at the rate of 32 kg per 4.5 kL of water to reach a level of 0.4%.

(0.4% = 4000 ppm = 4000 mg/L = 4 g/L.)

NOTE: THE AMOUNT OF SALT REQUIRED IS DEPENDENT ON THE DESIGN OF THE CHLORINATOR ALTHOUGH 0.4% TO 0.6% IS THE MOST COMMON.

The total alkalinity of the water must be adjusted to 110 to 150 mg/L and the pH to 7.6 and low hardness, as Calcium levels of more than 160ppm may plate out on the electrode and redue its efficiency. For the same reason, superchlorination must be by using liquid Chlorine, not granular.

Recommended filtering times are as follows:-

Summer	8-12 hours	daily
Spring & Autumn	4-6 hours	"
Winter	3-4 hours	"

The time run is also dependent on bathing load and local weather conditions.

Salt needs to be added a couple of times a year to maintain the recommended salt concentration (and dependant on rain-fall). The average home pool requires about 100 to 150 kg of common salt per year.

Typical Salt Cell (Clear PVC - not normally GREEN)

The cell of the salt chlorinator will become coated with Calcium from Calcium Chloride in the pool, and should be checked monthly - according to the manufacturer's instructions, and cleaned if necessary.

This usually involved dismantling the Cell container, removing the Cell mechanism, soaking in a mild Acid solution or vinegar (the Calcium-coated electrode will "fizzle" while this takes place) until appearing cleaned, checking for any obstructions between the leaves of the cell, and reversing this procedure to rerturn the cell holder into the unit body in the return pipe run to the pool.

Periodic super-chlorination using Sodium Hypochlorite or DiChlor is still necessary, unless the salt chlorinator has an in-built manual super-chlorination button for this purpose. Calcium-based Chlorines should never be used with salt chlorinators.

ALGICIDES

There are different kinds of algaecides: Copper-based algaecides use copper to treat algae growth and are most effective against mustard and green types of algae. Copper algaecides will not cause foam in a swimming pool, which can be a problem when using "Quat" algaecides. Although they are effective against many forms of algae, copper algaecides can cause stains on the surface of a swimming pool if the product is not used properly. Copper algaecides cannot be used in a swimming pool using a biguanide-based sanitizing system (such as Baquacil or SoftSwim).

The "Quat" or "Polyquat" algaecides are quaternary ammonium compounds (instead of a copper formula), which treat and prevent algae growth in a different way. These algaecides are safer to use than a copper-based algaecide because they will not stain a swimming pool. If you have experienced any pool stains caused by metals in the past, you should use a quat or polyquat algaecide to treat your swimming pool. Although quats cannot cause staining, these algaecides may cause foaming if not used properly. Polyquat pool algaecides cannot cause staining or foaming, and are typically more expensive than the other forms of algaecides.

A couple of weeks of uncontrolled algae growth can turn the average pool into a swamp.
The most annoying form seems to be 'black spot' and the black spot problem seems to be more than merely algae. A summary of black spot information prepared in 1980 found the spots can be a swarm of micro-organisams such as fungi, bacteria and algae or they can be cobalt compounds which appear in improperly constructed fibreglass pools filled with alkaline waters.

Algae cannot survive when the Chlorine residual level is maintained at the normal level of 0.6 mg/L or higher. However, algae problems can occur when the available Chlorine falls below the desired level.

This can occur accidentally after heavy bathing loads, after severe wind or rain storms, or when the pool owners are on holidays. A chemical marketed as an algAcide may be used as an added precaution in these conditions.

Such algAcides, normally available as liquids, should be added to the pool in accordance with the manufacturer's instructions. A typical dosage would be IL for a 60 kL pool, with a follow-up dosage of 150 mL every 7 days. The regular use of such an algicide not only reduces the risk of algae forming, but also tends to reduce the formation of a scum line on the tiles.

ALGACIDE DOSAGE RATE

(per 10 Kl – i.e. for 40Lk pool (40,000 Liters) multiply by 4)

kl	Initial Dose	Weekly Dose	Heavy Dose	Winterising
10	150ml	25ml	300ml	450ml

When evaluating algAcides, it is probably most important to know whether the concentration recommended for the product is to prevent growths of algae (algastatic) or if it will kill established growths (algAcida 1). In most cases there will be a loss of algAcide as the water is continuously filtered due to absorption on sand or diatomite of the filter bed and it is usual after the initial dose to follow up with smaller weekly doses.

Some algicides possess a high Chlorine demand and therefore rob the water of its Chlorine residual. Others may cause frothing in the water and in the filter.

It should also be noted that some strains of algae will build up a resistance to some types of organic algicides.

ACID AND ALKALINE CHEMICALS

ACIDS

These are used to lower a high pH reading. The common chemicals used are Sodium bisulphate (also known as dry Acid) which is a granular powder, and hydrochloric Acid (HC1, also known as muriatic Acid or spirits of salt) which is a liquid.

Precautions to be taken with Dry Acid: Always add the required amount of dry Acid into a bucket of tap water, then dissolve it before adding it to the pool water. This will prevent any bleaching of the pool floor.

Precautions to be taken with Liquid Acid: Always add liquid Acid to a bucket of tap water before adding it to the pool. This will avoid splashing the skin with Acid and also will dilute the Acid to some degree. Minimum dilution rate n the bucket should be 1 litre of Acid to at least 10 litres of water.

Use liquid Acid with care vinyl lined pools as the Acid may damage the liner if it is poured in undiluted and it settles on the floor. Tip into the return line eyeball stream or use dry Acid instead (1 litre of liquid Acid is equivalent to 1.25 kg of dry Acid).

Do not add any more than one litre of liquid Acid per day, despite the amount required by the Acid demand test.

Precautions to be taken with Acids in General: Pour the diluted Acid into the stream of water issuing from a pool outlet to avoid any deleterious effect on the interior surface of the pool. Never pour diluted Acid into the skimmer box as it may etch the plastic.

Always run the filter when Acid is being added to the pool and after the event for at least two hours to distribute the Acid well before retesting.

Do not add Acid to any pool with a Chlorine reading over 2 mg/L as it may go green.
Wait for the Chlorine level to drop.

Remember that Chlorine and Acid should not be added to your pool at the same time. Allow at least one or two hours between the addition of Chlorine then Acid.

Keep Acid well away from granular Chlorine powders as an explosion may result.

ALKALI

These are used to raise a low pH reading. The common chemicals used are Sodium carbonate (soda ash) and Sodium bicarbonate (also known as pH buffer or dry alkali or ph Stabiliser).

If slight adjustments need to be made to raise pH, it is probably better to use Sodium bicarbonate as this product has a lower pH than has Sodium carbonate and use of it will not raise the pH excessivley.

If the pH is below 6, it is probably better to use Sodium carbonate. However, use small amounts only and correct over a long period of time (days rather than hours).

Add either of these chemicals to a bucket of water before adding to the pool. Do not pour undiluted chemicals directly into the pool.

QUANTITIES REQUIRED ADJUSTING pH

Most manufacturers publish recommendations as to suitable quantities, both on their labels and advertising literature, so check the labels!.

A typical guide is shown below:

pH ADJUSTMENT CALCULATION CHART

kl	Alkali	Dry Acid	24 Hour dosage rate Liquid Acid
10	120g	120g	100ml

The only reliable method of determining pH is by regular testing.

DANGEROUS CHEMICALS

When you are deciding on the chemicals to keep your pool clean, take into account their hazards. Whatever you choose, be prepared to take stringent safety precautions.

Hypochlorites

These are strong oxidising agents which can explode when they come into contact with moisture and any organic substance. Dry Chlorine is potentially more dangerous than liquid Chlorine because of the larger surface area. If, for instance, dry Calcium Hypochlorite is tipped into a bucket with even a race of oil in it, a chain reaction can commence which causes the Hypochlorite to erupt. Coming into contact with the user's clothes or skin only gives the reaction more organic material to feed on.

Sodium DiChloroisocyanurate and Sodium trichloroisocyanurate

Both of these give off toxic Chlorine and carbon monoxide fumes when heated to decomposition. Flame temperatures are required to break down these or quaternary ammonium compounds such as Hydrophane 7, but a fire could lead to a tragedy.

Cyanuric Acid

Information about the toxicity of Cyanuric Acid is difficult to come by.

For safety's sake, take the following precautions.

DON'T store pool chemicals in close proximity to each other or to other household chemicals like mower petrol, turpentine or pesticides.

DO store them out of reach of children, i cool, dry, clean conditions.

READ the labels carefully and follow the instructions precisely.

BUY an extra bucket and scoop and never use them for anything except the one pool chemical.

WHEN mixing your pool chemical with water, always pour the chemical into the water slowly, stirring as you go. NEVER add water to the chemical.

WASH your hands and exposed skin areas thoroughly after using any pool chemical.

If you accidentally splash yourself with chemical, flood the area with clean water immediately. See a doctor if your skin is burnt or your eyes inflamed.

pH OF VARIOUS POOL CHEMICALS

Alkaline

Sodium Hydroxide (Caustic Soda)	pH 14
Sodium Carbonate (Soda Ash)	pH 13
Sodium Hypochlorite (Liquid Pool Chlorine)	pH 12
	pH 11
	pH 10
Calcium Hypochlorite	pH 9
Sodium Bicarbonate (Dry Alkali)	pH 8
Sodium DiChlor	pH 7
	pH 6
	pH 5
	pH 4
	pH 3

Sodium Trichlor pH 2

pH 1

Dry Acid (Sodium Bisulphate)
Hydrochloric Aci d pH 0
Acid

EFFECTIVENESS OF FREE CHLORINE WHEN CYANURIC ACID IS USED

Considerable experience has been gathered in the use of Cyanuric Acid as an aid in maintenance of free Chlorine levels in swimming pools. However, much knowledge has yet to be gained in ascertaining the real effectiveness of this material, particularly in extreme heat conditions. It is considered desirable to attempt to summarise what is known at this stage about Cyanuric Acid and to point out the areas in which there is some doubt.

In this way you will be aware of the limitations in our knowledge, and you may also discover answers to the questions which have not as yet received adequate answers.

Cyanuric Acid, when present in swimming pools at a concentration of between 30 and 50 mg/L, is able to protect the free Chlorine from destruction by sunlight and to maintain concentrations of up to 1.5 mg/L even during the strongest sunlight conditions.

When Chlorine tests are carried out, Chlorine appears to be present during the tests being carried out, and the Chlorine appears to be present as Free Chlorine. It reacts in the way that free Chlorine would in test procedures.

There is, however, some doubt as to whether ***it really is present*** as free Chlorine. It is considered by some Lab Workers that it is present as ***mono chloro isoCyanuric Acid*** and that, although this will test as free Chlorine, its effectiveness as a bacericide ***is nowhere near that of free Chlorine***. This would be similar to the well-known observation that ***Chlorine in combination with ammonia*** (chloramine) lacks the effectiveness of free Chlorine, although the reduction in effective is not as marked.

US LABORATORY AND FIELD STUDIES (Background information for your reference)

Laboratory investigations in the USA have shown that Chlorine in the presence of the specified concentrations of Cyanuric Acid has only 1/3 - 1/8 of the sterilising action upon bacteria that is shown when Cyanuric Acid is not present.

The experiments which were carried out by addition of cultures of bacteria to water which contained Cyanuric Acid and Chlorine and Chlorine alone showed that using E. coli bacteria, the 'free' Chlorine residual value had to be increased more than eight-fold in the presence of 50 mg/L of Cyanuric Acid to obtain the same kill as when no Cyanuric Acid was used. With Strep. Faecalis bacteria was used, an approximately four-fold increase was required and with Staph. aureus bacteria a three-to-four -old increase was required. While these observations were made under laboratory conditions and therefore may not apply directly to swimming pools, they are nevertheless highly suggestive. Furthermore, they point up the need for actual experiments to be carried out under operating conditions in swimming pools to determine whether destruction of the above bacteria is really taking place when Chlorine has been stabilised with Cyanuric Acid.

Robinton and Mood, who carried out this work, communicated their findings to the Annual Meeting (in October 1965) of the American Public Health Association meeting in Chicago. Their paper was entitled "An Evaluation of the Inhibitory Influence of Cyanuric Acid upon Swimming Pool Water Disinfection". They suggest that the standard for 'free' Chlorine residual in a pool should be changed where cyanurates are being used to read, "If Cyanuric Acid is used as a stabilizing agent of residual Chlorine, or if the source of residual Chlorine is from a chlorinated cyanurate, a (free) Chlorine residual of at least 1.5 mg/L shall be maintained throughout the pool whenever it is open or in use".

A similar investigation, which also examined operational swimming pools, was included in a larger investigation into swimming pool disinfection carried out in Britain between 1972 and 1975 by Warren and Ridgeway.

A result of their studies was to recommend free Chlorine residuals in the presence of 25 to 50 mg/L of Cyanuric Acid to be some three times greater than the recommended free Chlorine residuals when Cyanuric Acid is not used.

Favero, Drake and Randall found in studies carried out in private swimming pools which wee using Sodium DiChloro isocyanurate, that the incidence of the organism Pseudomonas aeruginosa was high. This organism is responsible for ear infections which are difficult to cure. Other workers isolated the Pseudomonas organisms from the pool and from ears of swimmers who had been infected and laboratory study proved that they were identical. The observed Chlorine residuals in these cases were 0.5 mg/L

The bacteriological situation with respect to the use of Cyanuric Acid can be summarized in the following way. Evidence has been presented that the presence of Cyanuric Acid appears in some way to reduce significantly the effectiveness of free Chlorine in killing various bacteria. While theres results have been obtained mainly under laboratory conditions, there is a certain amount of evidence that this phenomenon applies under pool conditions.

It is particularly important that these doubts be resolved as quickly as possible since if bacteria are not being killed by free Chlorine in the presence of Cyanuric Acid, viruses will not have been destroyed. In many ways this is an even more serious difficulty. The ability of viruses to resist chloramine disinfection means that there must be an adequate assurance that the Chlorine present (reacting and measurable as free Chlorine) does in fact destroy bacteria as quickly as does free Chlorine in the absence of Cyanuric. Only with this assurance could one feel reasonably confident that viruses were being concurrently destroyed.

USING CYANURIC ACID

The use of Cyanuric Acid, which undoubtedly has shown the ability to hold high levels of free Chlorine in swimming pools even under strong sunlight conditions, should nevertheless be approached with some caution.

It is not sufficient merely to maintain free Chlorine - the Chlorine must be shown to exercise the killing action on bacteria which is the purpose of its addition. Because Cyanuric is able to maintain free Chlorine at high concentrations, it should not be too difficult to maintain levels much higher than were previously regarded as essential.

Once the required free Chlorine residual (in the presence of Cyanuric Acid) has been established, the economics of the use of Cyanuric Acid plus Chlorine necessary to establish and maintain the higher Chlorine residuals will be cheaper than the cost of continually maintaining the lower Chlorine residuals (without Cyanuric Acid) depends on the rate at which the lower residual is destroyed by sunlight. Thus, the relative economies will vary from pool-to-pool, depending on climatic conditions.

In the meantime, until the situation has been clarified, it is recommended that levels of free Chlorine in pools using Cyanuric Acid be kept at a minimum of 3 mg/L of free Chlorine.

(*) = Check & Verify

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