Water Chemistry

Combating Chloramine Formation in Commercial Indoor Pools

By Tim Batt MISPE$_{UK}$

Aquatic centre managers with indoor pools will know the continual challenge of maintaining adequate pool water disinfection and clarity whilst reducing chemical smell from the pool in the general indoor environment.

The strong chlorine smell associated with indoor pools is largely caused by the formation of chloramines, the undesirable by product of the combination of chlorine with organic loading in the water. Several different species of chloramine go to make up the 'combined chlorine' reading of the water, which is typically measured at the poolside using a test kit and 'DPD no3 tablet'.

The three forms of chloramine that go to make up the combined chlorine content in pool water are monochloramine (NH2Cl), dichloramine (NHCl2) and trichloramine (NCl3). The results of the presence of these at combined chlorine levels of 0.5 mg/L or above are poor air and water quality. Mono and dichloramine will irritate swimmers eyes and skin. Trichloramine causes foul smelling air and causes corrosion of structure, fixtures and fittings in indoor pool environments. Reduced oxidation / disinfection and the encouragement of algae growth are also the result of chloramine presence.

Health departments around Australia generally require that the combined chlorine reading is kept at below half the free chlorine reading at all times. Failure to do so gives those authorities sufficient grounds to close a commercial pool. Typically the pool will then be ordered to 'superchlorinate' and/or dump water to ensure that the recommended levels can be consistently maintained. Dumping large amounts of water is clearly an expensive exercise for many facilities and is something that could be avoided by better water chemistry management in a lot of cases.

By installing a proven and reliable automatic water chemistry controller to accurately control pH and chlorine disinfection strength (HRR/ORP), datalog pool readings and events, the operator is immediately removing the guesswork and 'hit and miss' nature of manual chemical dosing. This information can be downloaded to PC and will be automatically graphed. This can be used as an accepted replacement for manual record keeping - a big time saver! Correct and consistent pH is key to effective pool disinfection, with considerably more of the desirable 'hypochlorous acid' (HOCl) present in a free chlorine residual at the

lower end of the typical pool pH range of 7.2-7.8. To achieve this the pool's water chemistry must be manually 'balanced' at all times, in line with the 'Langelier Saturation Index' with the ideal range being +0.1 to +0.5 LSI. Consistently maintaining good levels of hypochlorous acid in the pool is the most effective way of reducing chloramines, with 'breakpoint chlorination' being the ideal situation. This is where chloramines are eliminated without producing excess trichloramine.

Superchlorination, or super doses of free chlorine, can be useful in the reduction of chloramines after they have formed. However, unless adequate levels are reached (12-15 times the combined chlorine levels) and good pool surface ventilation is possible, all that may be achieved is the formation of yet more chloramines. Health departments favour the continual 'wastage' of a small percentage of pool water to control chloramines, as mains water is usually of a better quality; but be aware that bore water may not be.

There are now several other ways to assist your pool plant in improving water quality, disinfection and clarity whilst also preventing the formation of chloramines in busy pools:

- Trying different forms of chlorination than liquid chlorine (eg dry chlorine/ calcium hypochlorite briquettes)
- The addition of ozone or UV systems to your plant to assist with oxidation in the water
- The use of 'non-chlorine/oxygen shock' type products to assist specifically by the direct oxidation of organics in the water.

Something that is not commonly known about breakpoint chlorination, is that as chlorination is performed at certain pH levels, different chemical reactions take place in the water. Equation 3 below shows that it is possible to get 95-99% conversion of inorganic chloramines to nitrogen gas - which is an ideal situation for water quality in a well ventilated indoor pool area. Almost a pool water treatment 'nirvana' in fact!

Breakpoint reactions

(Eq. 1) NH3 + HOCl - NH2Cl (monochloramine) + HCl

(Eq. 2) NH2CL + HOCl - NHCl2 (dichloramine) + HCl

(Eq. 3) 2 NH2Cl + HOCl - N2 (nitrogen gas) + 3 HCl + H2O

Chlorination at slightly alkaline pH (dry chlorine briquettes with venturi feeder)

(Eq. 4) NHCl2 + HOCl - NCl3 (nitrogen trichloride/'trichloramines) + HCl

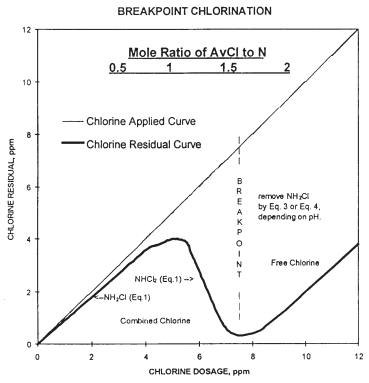
Chlorination at lower pH and excess available chlorine (chlorine gas)

The latest dry chlorine (calcium hypochlorite) briquette feed systems which use a booster pump and venturi eductor to properly mix the chemical with a proportion of the pool water provide:

- Slightly higher available chlorine concentrations at slightly alkaline pH
- Longer residence times via the filter to drive the chloramine destruction reactions

With a lower pH (eg chlorine gas addition) there is a tendency to produce trichloramine as in Equation 4.

With a higher pH (eg liquid chlorine addition) there is a tendency to produce undesirable nitrates via a complex series of hydrolysis and oxidation reactions *(see chart below)*.



While ozone and UV systems can be extremely effective at helping chlorine to do it's oxidation work, it is important to be aware that for commercial pools these units represent a substantial capital investment cost (usually well over $50,000). In the case of ozone in particular, there can also be the need for costly ongoing maintenance. Ozone is toxic to bathers and must therefore be removed from the water by the plant with GAC (carbon filtration) before it is returned to the pool. UV exposes the water briefly to set intensity UV lamps within the plant. Neither ozone or UV therefore will provide a chemical residual in the pool itself - this job will still have to be done by chlorine.

The use of 'non-chlorine shock' or 'oxygen shock' products have become commonplace in heavily loaded pools and spas in recent years. One patented system is available for commercial pools, called 'ECS', which automatically proportions their dosing alongside dry chlorine to specifically target organics in the water. The disinfection result of this can be similar to that achieved by ozone or UV systems. Often with less corrosive and obnoxious chloramines in the pool water and atmosphere. By organics being specifically targeted in the filtration plant and the pool itself, chlorine is left free to get on with its disinfection work and bather comfort is assured. One downside of using these additional chemicals, is that they can interfere with DPD test kit readings and show up as combined chlorine in the No3 test. Most health departments are now aware of this and do not object to the use of 'shocking agents' on any grounds. Overall their use can only be a positive for water quality and bather safety.

As the industry moves forward, new chemicals, processes and technologies will emerge for the treatment of this basic water chemistry problem. One constant has been at the fore all along - proper and effective breakpoint chlorination. A new form of chlorine is now available for commercial pools in Australia - dry chlorine briquettes. It is showing good results at achieving breakpoint chlorination and overall economy is good. It should be given full consideration bearing in mind the many potential benefits for your facility's pool, either indoor or out. There are now many commercial pool users around the country to talk to about it. Finally there is a *real alternative* to liquid chlorine!

Information provided by USF Stranco Aquatic Pty Ltd, Sydney
Telephone: (02) 9850 2822 Fax: (02) 9850 2898
Email: tbatt@usf.com.au Website: www.strancoaquatics.com