Interaction of Pool Water and Air Chemistry

INTRODUCTION

With the acceptance of ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) Code 62 concerning indoor air quality, more stringent reviews are required of an indoor pool's air quality. This technical bulletin summarizes the chemistry involved for pool water using chlorine and its effects on air quality, and vice versa. It also reviews the impact of ventilation air on air quality, as well as the use of special filters to remove airborne contaminants in a pool facility.

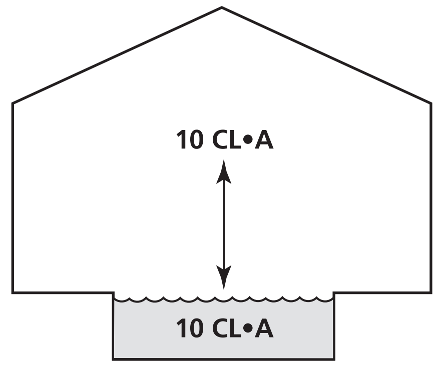

Figure 1 - Pool facility at equilibrium.
(Note: CL•A = chloramine concentration)

WATER CHEMISTRY

Many detailed articles are available about this subject from other sources. This bulletin summarizes only the basics about pool chemistry to provide an overview. Contact the NSPI (National Spa and Pool Institute) for more information.

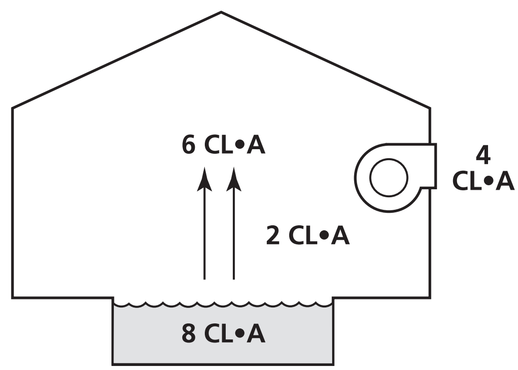

Figure 2 - Outdoor air changes equilibrium point.
(lower CL•A concentration yields higher ratio)

Chlorine is added to water to form hypochlorous acid (HClO), an excellent bactericide. In this solution it is known as "free chlorine," and is highly reactive. The free chlorine reacts with organic wastes introduced into the pool water – such as sweat, urine, perfumes and other ammonia-based impurities – to form new "combined chlorine" compounds. These new compounds have very poor bactericide properties. If enough free chlorine is present, it reacts with the combined chlorine compounds to further break them down into basic elements, such as H2O (water), CO2 (carbon dioxide gas), N2 (nitrogen gas) and various salts. When this breakdown process occurs, the pool is deemed to be safe for swimmers.

Whether or not the complete breakdown can occur, however, is a function of the amount of free chlorine available as compared to the amount of ammonia-containing wastes present. Table 1 summarizes the pool conditions resulting from various ratios of free chlorine to chlorine compounds.

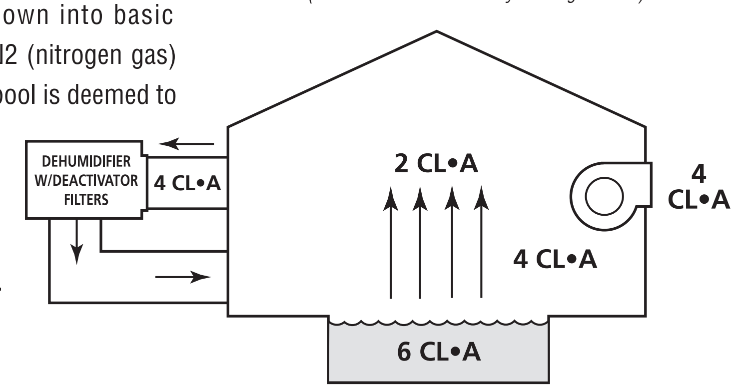

Figure 3 - Outdoor air and chlorine removal filters significantly change equilibrium point for highest ratio.

Table 1

Ratio	Compound Present	Comments
<5:1	Mono-chloramines	Quick reaction; very poor disinfecting capacity (100x less)
5:1 to 10:1	Di-chloramines	"Chlorine" odor; poor disinfecting capacity
>10:1	Basic elements	Properly treated pool

As Table 1 shows, a constant source of free chlorine is needed to ensure the complete reaction. This is known as breakpoint chlorination. If the combined chlorine compounds are not eliminated, pool "shocking" is required: a larger dose of chlorine is added to the water to complete the reaction and balance the pool.

AIR CHEMISTRY

The pool room odor commonly described as "chlorine" (which, in fact, is the odor produced by chloramine compounds), occurs when the pool water chemistry is improperly balanced. The chloramines readily release into the air and reach a balance based on a chemical law known as the partial pressure law. In laymen's terms, this law states how much chloramine remains in the water and how much is released to the air under various conditions.

The ASHRAE 62 ventilation code recognizes this "chlorine" smell as a potential indoor air quality problem and offers specific recommendations for the introduction of outdoor air based on the size of the pool and deck. (Refer to Desert Aire's *Technical Bulletin 5 – Ventilation Air for Indoor Pools,* for details on these recommendations.) The code attempts to replace the indoor air once per hour to eliminate the odor.

Since nature requires a balance, removing some of the chloramines from the air will cause more chloramines to be released from the water. Table 1 shows that the release of more chloramines to the air will improve the free chlorine ratio, bringing the pool chemistry a step closer to proper balance.

MORE OUTDOOR AIR

The response of some pool designers is to go beyond ASHRAE 62 air quality recommendations. That scenario, however, can introduce other problems.

First, in cold climates, wintertime outdoor air must be heated. For even the smallest pools, this adds up to thousands of dollars per month in increased utility bills.

Second, the code requires that relative indoor humidity remain below 60 percent. Summer conditions in most locales add humidity to the space, so when an increased air volume is introduced, the facility may no longer be compliant with the indoor humidity code.

CHLORINE DEACTIVATING FILTERS

Adding special chlorine deactivating filters to the pool room results in additional chloramine removal, thereby decreasing the amount of free chlorine required to reach breakpoint chlorination. Using these types of filters in lieu of bringing in more outdoor air avoids temperature and humidity problems and treatment expense in a pool facility.

Chlorine deactivating filters are added to the dehumidification air handler as an alternative to standard disposable filters.

CONCLUSION

While this technical bulletin does not attempt to cover all chemistry issues (for example, the influence of pH on free chlorine), it does demonstrate the basic chemical interaction occurring in an indoor pool facility.

The following design specifications are recommended:

1. **Automatic chlorate control system.** The chemical feed pump must be sized to match worst case pool loading.
2. **High water turnover** to better mix the pool, to avoid dead spots, and to provide better chlorine concentration measurement and control.
3. **Ensure ASHRAE 62 outdoor air compliance** to aid in breakpoint chlorination.
4. **Add chlorine deactivating filters** to help balance energy, humidity and water chemistry demands.

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