

TwinOxide[®]

Superior Water Disinfection Power

Application Document

The usage of TwinOxide[®] for THM control in swimming pools

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Introduction

The conventional disinfection methodology for swimming pools is based on adding chlorine to the water. After adding chlorine, hypochlorite acids arise with a high oxidation potential taking care of disinfection. The disadvantage of this concept is that chlorine combined with water (containing all kind of (organic) materials e.g. skin particles, bath oils, nitrogen, etc.) builds chlorine based substitution products. The major substitution products in swimming pools are TriHaloMethanes (THM's), Halo Acetic Acids (HAA's) and chloramines (bounded chlorine), commonly known as disinfection by-products (DBP's).

THM's and HAA's are proven to be carcinogenic when enduringly inhaled, ingested, or even absorbed through the skin and therefore pose a risk for human health. A recent study¹ conducted by the University of Barcelona under auspice from Dr. Christina Villanueva reveals that swimming in chlorinated water may considerably increase the risk of bladder cancer.

The table below outlines the most common THM's that can be found in water that has been treated with a chlorine-type disinfectant:

CHCl ₃	CHClJ ₂	CHBr ₂ J
CHCl ₂ Br	CHClJ ₂	CHBr ₂ J
CHClBr ₂	CHClBrJ	CHJ ₃
CHBr ₃		

Approximately 95% of the THM's are built as chloroform. In water that contains bromide, the substitution results in the building of bromine. Chloramines are responsible for the annoying swimming pool smell and have a negative influence on the skin (degreasing, irritation of eyes and activation of mucous glands). A further disadvantage of disinfection with chlorine is the dependence of pH-values of hypo-chlorine acids. When the pH-values of the water increase, the level of Hypochlorite anions increases and causes a weaker oxidation potential.

Amid growing health and environment conscience among the public, many governments are further limiting THM tolerance by tightening laws and regulations for both drinking water (cf. EU Directive 98/83/EC) and swimming pools.

Reduction of chloramines

Based on the high oxidation potential of TwinOxide® (2.6 more oxidation capacity compared to chlorine) chloramines are disturbed by oxidation. The arising chlorite is transformed into chlorine dioxide and chlorate (caused by the low-chlorine acids). The bounded chlorine is transformed in to nitrogen (80% of our air contains nitrogen) and into kitchen salt. Therefore based on the equation bounded chlorine disappears in the pool water. The remaining level of bounded chlorine is related to the level of chlorine dioxide – the higher the chlorine dioxide concentration the faster the bounded chlorine is broken down. When adding continuously TwinOxide® to the water, a buffer of chlorine dioxide is built that is sufficient to break down the bounded chlorine.

Reduction of THM's and other toxic by-products

It is of importance to acknowledge that the presence of chlorine in the pool water is the main driving factor behind THM formation. Therefore, any reduction of chlorine levels in the water will contribute

¹ Bladder Cancer and Exposure to Water Disinfection By-Products through Ingestion, Bathing, Showering, and Swimming in Pools, dr. Christina Villanueva et al., American Journal of Epidemiology, vol. 165, no. 3.

without delay to less formation of the THM's. The building of THM's is caused due to a reaction with free chlorines (low-chlorine acids) with precursors. These precursors are organic materials that can occur in high concentrations in the swimming water and are e.g. caused by organic materials in the surface water or by cleansers of bath guests. The reactions of free chlorines (low chlorine acids) with these precursors take place in the field of Halo form reactions that build the THM's. THM's are considered as stabile chemical compounds and are not easily reduced. The eradication of THM's can be achieved by usage of a strong oxidizing agent or active carbonate powder that absorbs THM's but involves higher usage of cleansing water and disinfectants. The latter may not always be effective as not all substances in the THM spectrum are able to be absorbed by the active carbon. Furthermore, the true function of active carbon is declining as microbiological fouling of the active carbon is increasing. The addition of TwinOxide® into the chlorinated water will reduce the THM level (caused by chlorination).

The usage of TwinOxide® for THM control

The combination of TwinOxide® in combination with chlorine in swimming pool water is focused on preventing of THM building resulting in negligible amount of THM's. The reaction of TwinOxide® on precursors results in the absence of reaction of precursors with free chlorine caused by an oxidation process. This mechanism of TwinOxide® results in a change that provokes these precursors from building THM's. The result is a negligible level of THM's in the pool water. The level of THM's is depending on the level of precursors, the level of free chlorine as well as the level of TwinOxide® in the pool water.

As chlorine is available in the water, the addition of TwinOxide® will amplify the function of chlorine as a disinfectant (the chlorine dioxide molecule has more oxidation power and disinfection power). The addition of TwinOxide® to chlorinated water will deliver a better control on (toxic) by-products, their levels and on the quality of the water in the process in general. The permanent of TwinOxide® in the water ensures optimized reduction of THM's (and HAA's). It is important to understand that the THM's may be reduced and that maximum 99% reduction yield can be achieved by adding TwinOxide to chlorinated water.

When applying TwinOxide® in combination with chlorine for THM control purposes, the following topics should be considered:

- The most effective way to avoid formation of THM's is NOT applying chlorine!
- Generally speaking, the lower the chlorine dosage, the less formation of THM's.
- When using TwinOxide® in combination with chlorine, the lower the chlorine dosage, the higher the THM reduction yield can be achieved by TwinOxide®.
- An **indicative** dosage rate TwinOxide® equaling 10% of the free chlorine concentration present in the water has proven to result in a negligible level of THMS in the pool water. The actual yield is not predictable but can only be sorted out in practice as there are many influencing variables available in a swimming pool.
- As every pool has distinctive characteristics, the fine-tuning of the dosage rate is always subject to measuring and adjusting on site.
- Periodical stand disinfection of filters is of great importance.
- Sufficient addition of make-up water per swimmer on a DAILY BASIS is required to contribute to optimizing the swimming water and positively contributes to decreasing the risk of formation of THM's.