Ozone is a Safe Alternative to Chlorine for Pools

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According to market researchers, the U.S. market for swimming pool equipment and maintenance products was valued at over $3.4 billion in 2011 and it is expected to double in value by 2021.

History of Chlorination

Chlorination, or the addition of the element chlorine to disinfect water, has been used since the late nineteenth century. In 1897, during Britain’s largest outbreak of typhoid fever, a bacteriologist named Sims Woodhead, added chloride of lime to the water supply in Maidstone, in the town of Kent. The epidemic that occurred in south east England affected nearly 2,000 people, 143 of whom died. At its peak, 900 people contracted the disease in a two week period. Chlorination was a difficult procedure that required several attempts. The water sterilization of the waterborne outbreak was successful and laid the foundations for continuous water treatment.

By the early 1900s, municipal water treatment engineers had mastered the use of chlorine. The first American swimming pool to be sterilized with chlorine was Brown University’s Colgate Hoyt Pool. In 1911, graduate student John Wyomond Miller Bunker measured bacterial counts of 300 to 500 bacteria per cc (incubated on agar at 37 degrees Centigrade for 24 hours). When the deep end of the pool was stirred up by use, the counts rose as high as 1,000.

Bunker’s first chlorine application was hyperchlorite of lime to 2 liters of pool water at a concentration of 1 part per million (ppm). His results were spectacular. Bacteria counts went from 700 to 0 in only 15 minutes. The experiment was then duplicated with an application at 0.5 ppm. For a full-scale application, the powdered compound was placed in a cheesecloth bag and dragged over the pool until the final concentration of chlorine was 0.5 ppm. Surface bacteria counts fell from 500 to 30 in 15 minutes, to 10 in 30 minutes and complete sterility after an hour.

Association for Promoting Hygiene & Public Baths

Although large public baths existed in the ancient world, the first modern public baths were not introduced until the nineteenth century. Later, public baths became public swimming pools.

At the turn of the century, although most middle and upper-class single homes had bathtubs, tenement dwellers had tubs in their kitchens where regular bathing was difficult. In Britain, the Public Baths and Wash-houses Act was enacted in 1846 as a public health measure to improve personal hygiene. The Act empowered local authorities across the country to build public swimming baths with community funds. By 1915, most towns in Britain had at least one public bath.

Ozone Found Superior to Chlorine in 1918

In 1918, in New York, Wallace A. Manheimer, Ph.D., secretary of the American Association for Promoting Hygiene and Public Baths, and editor of the Association’s journal, conducted water purification experiments at the research laboratory of the New York State Department of Health. Manheimer’s experiments and field trials concluded that ozone was superior to chlorine for swimming pools. His study, published in the Journal of the American Medical Association, explains that chlorine is not suitable for water with high concentrations of organic matter because of odor problems. He also explains that ozone is insoluble in water and has no upper limits on the amounts that can be introduced.

Note: Organic matter in swimming pools originates from bathers in the form of sweat, dander, urine and other organics. Chlorine reacts with organics and produces nitrogen trichloride, aldehydes, halogenated hydrocarbons, chloroform, trihalomethanes and chloramines.

Dangerous Halogenated Disinfection By-Products (DBPs)

For most of the twentieth century, chlorination has been widely used for swimming pool sterilization. However, America’s faith in chlorine was shaken in 1974 when scientists...
discovered that chlorination of drinking water leads to the formation of a variety of dangerous Disinfection By-Products (DBPs) including:

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<thead>
<tr>
<th>DBP</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trihalomethanes (THMs)</td>
<td>THMs are organochlorines considered carcinogenic. Chloroform is the common name of a well-known trihalomethane. Chloroform's chemical name is trichloromethane.</td>
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<tr>
<td>Haloacetic Acids (HAAs)</td>
<td>HAAs are organochlorines considered to be potent carcinogens. Note: Organochlorines (OCs) are compounds that contain carbon, chlorine, and hydrogen. Approximately 11,000 OCs are used in manufacturing. Their chlorine-carbon bonds are very strong which means that they do not break down easily. Well-known organochlorines include DDT, dioxin, polychlorinated by phenyls (PCBs) and chlorofluorocarbons (CFCs) (6). The metabolism and toxicity of organochlorine compounds have been studied extensively (7).</td>
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Tap Water Studies Linked to Still Births
Studies in the U.S., Canada and Norway have linked chlorine byproducts in tap water to higher risks of miscarriages and stillbirths in pregnant women. The risk is linked to exposure to trihalomethanes (THMs) which forms when chlorine reacts with organic material. THMs are also widely recognized carcinogens. THM studies include:

- **Santa Clara and Walnut Creek, California**
  In 1998, California health department investigators Kirsten Waller and Shanna Swann examined the records of 5,144 pregnant women from the Fontana, Santa Clara and Walnut Creek areas. They reported a 15.7% higher chance of miscarriage among women who drank 5 or more glasses of chlorinated water per day (8).

- **Oslo, Norway**
  In 1999, Dr. P. Magnus with the Department of Population Health Sciences, National Institute of Public Health in Oslo, Norway led a study that linked the Norwegian waterwork registry, containing 1994 data on chlorination practice and color (an indicator for natural organic matter), with the Medical Birth Registry for 1993-1995. The study provides evidence of the role of chlorination of humic water as a potential cause of birth defects, in a country with relatively low levels of chlorination byproducts (9).

- **Halifax, Nova Scotia, Canada**
  In 2004, Dr L. Dodds with the Perinatal Epidemiology Research Unit, Department of Obstetrics and Gynecology at Dalhousie University conducted a population-based case-control study in Nova Scotia and Eastern Ontario, Canada, to examine the effect of exposure to THMs on stillbirth risk. Their results provide evidence for an increased risk of stillbirth associated with exposure to chlorination byproducts through ingestion and showering and bathing (10).

While regulations in Canada and the United States have placed restrictions on the levels of THMs allowed in tap water, no such regulations exist for swimming pool water. This is in spite of a study that found a 1 hour swim resulted in a chloroform dose 141 times the dose from a 10 minute shower and 93 times greater than exposure by ingestion of tap water.

Chlorinated Pools Affect Respiratory Health
Researchers who have studied the air quality around chlorinated swimming pools have found that chlorine-containing compounds in the air affect the respiratory health of those who work as swimming attendants, instructors, the public who use the pools and competitive swimmers. Reports about this type of pollution include:

- **Leuven, Belgium**
  In 2002, B. Nemery, with the Unit of Lung Toxicology at the Catholic University of Leuven, led a team of researchers who reviewed recent reports of respiratory hazards associated with chlorinated swimming water. The authors found that swimming in chlorinated pools represents a hazard of pulmonary damage, and could even be responsible for the recently observed increase in asthma in Western societies (11).

- **Brussels, Belgium**
  In 2009, Alfred Bernard, with Department of Public Health at the Catholic University
of Louvain in Brussels, Belgium, led a study that estimated the burden of allergic diseases associated with chlorinated pool exposure among adolescents. The group concluded that "chlorinated pool exposure exerts an adjuvant (accelerated) effect on atopy (genetic predisposition) that seems to contribute significantly to the burden of asthma and respiratory allergies among adolescents (12)."

- **Louvain, Belgium**
  In 2010, C. Voisin, a faculty of medicine member at the Catholic University of Louvain in Brussels, Belgium, led a study to assess the consequences swimming in chlorinated pools during infancy and to test a hypothesis that infant swimming is associated with a higher risk of bronchiolitis. The researchers concluded that "infant swimming is associated with a dose-dependent increase in the risk of bronchiolitis." In their summary, they noted: "Exposure to chlorinated pools during infancy also interacts with bronchiolitis to increase the risks of asthma and respiratory allergies later during childhood, which suggests that the infant swimming practice may have a more long-standing impact on the respiratory health of children (13)."

- **Lille, France**
  In 2012, Valerie Bougault, faculty member in the Science of Sport and Physical Education Department at the University of Lille and Louis-Philippe Boulet, with the Quebec Heart And Lung Institute Research Centre, conducted a review of studies that address upper and lower respiratory ailments in competitive swimmers who train in indoor swimming pools. The authors found 74% of competitive elite swimmers had symptoms originating from upper airways including nasal obstruction, rhinorrhea, sneezing and nasal itching and 76% demonstrated airway hyperresponsiveness (AHR) and/or exercise-induced bronchoconstriction (EIB). Note: Airway hyperresponsiveness is easily triggered bronchospasm, or contraction of the bronchioles (14).

**Reducing or Eliminating Chlorine in Swimming Pools**

If American pool builders say that chlorinated pools are the best option, it may be due to the fact that the United States is one of the world’s largest producers of chlorine (15). Chemical-free pools are new in the United States, and it’s hard to find builders who are knowledgeable about alternatives. Most pool contractors sell ozonation equipment as a supplemental sanitizer to reduce reliance on chlorine. However, it's possible to rely solely on ozone by using a larger generator and running the recirculating pump continuously (16).

Chemical-free ozonation has been available in European swimming pools since the 1980s. As Americans get acquainted with ozone, European landscape architects are building chemical-free natural swimming pools that may represent a new trend: plants or a combination of plants and sand filters to keep the water clean and clear without chemicals (17)(18).

**References**


http://articles.x10.mx/pools_foreverozone.html


**Links**

- [German Technology: Ozone Water Treatment for an Argentinian Zoo](http://articles.x10.mx/pools_foreverozone.html)
- [German Technology: Ozone Water Treatment Spa, Belgium's Municipal Water Treatment](http://articles.x10.mx/pools_foreverozone.html)