

Ozone Generation for SWIMMING POOL DISINFECTION

By Shreyas B.



Ozone has been used in swimming pools and spas in European countries since the early 1950s and in the United States since about 1975. In India, the use of ozone has grown rapidly over the last decade. Numerous private, public and commercial pools have switched to ozone technology as people have become more concerned about chlorine and chlorinated byproducts.

Chlorine is a good sanitizer and oxidizer, but these processes create unpleasant and unhealthy by-products. When chlorine oxidizes organic contaminants (body wastes, soaps, cosmetics, etc) carcinogenic chlorinated organics (THMs) are produced in abundance. Chlorination of nitrogenous body wastes result in chloramines which cause an unpleasant smell and are the source of stinging eyes, ear and skin irritation. Despite these studies, most swimming pool managers are probably unaware that they are exposing their patrons to THMs. This problem is not widely known and for the most part is ignored by the media.

Ozone prevents the formation of scum line forming and filter clogging chlorinated organics, eye & skin irritating and hair and swimsuit discoloring chloramines. Upon completion of these significant oxidation tasks, ozone reverts to oxygen, leaving no by-products behind. To date, ozonation is the best water treatment solution available, yielding the most modern, safest and most environmentally friendly sanitation of pools and SPAs. However, not all ozone generation techniques will achieve the above benefits in a swimming pool.

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As of today pool owners/ consultants/ builders are being misled by fly by night ozone operators and marketers of UV ozone systems. They do not mention that it is UV ozone and offer no technical specifications of the equipment.

Ozone Generation

There are two basic methods for ozone generation; corona discharge (CD) method and ultraviolet radiation (UV) method. In practice, ozone is generated by passing an oxygen containing gas through either a high energy electrical field or a high energy radiation source, the former being corona discharge and the latter UV radiation. Only a portion of the oxygen is converted to ozone by these production techniques. With corona discharge an ozone concentration of up to 13% by weight is obtainable, however when generated by UV radiation a concentration of only 0.001-0.1% by weight is obtainable.

The effectiveness of ozone as an oxidant and disinfectant is very dependent on the ozone concentration and dose application (governed by Henrys law and Chicks law).

**Corona Discharge
vs. Ultraviolet
Generation.**

Description	Corona Discharge Method	UV Method
Ozone Generation	Oxygen containing gas is passed between the high voltage electrode and dielectric tube. When a high voltage AC power source is connected across this air gap a corona discharge occurs resulting in ozone generation. This is a highly sophisticated method of ozone generation.	This is a photochemical process and is far simpler and less expensive than corona discharge ozonators. Using this technique, air is passed over a UV lamp, from which a small portion of the oxygen is converted into ozone by high energy radiation.
Ozone Concentration	High concentration 1.5-13%	Minute concentration 0.01-0.1%

Ozone Effectiveness as Disinfectant	High	Ineffective due to very low ozone concentrations
Ozone Effectiveness as Oxidant	High	Very low
Solubility of ozone in water at produced concentrations (30 degrees temperature)	5-10% w/w	0.003% w/w. Low concentrations not suitable for high ozone mass transfer in water.
Practical Uses	Water and waste water disinfection and oxidation, pulp and paper, air treatment, medical, process requirements.	Recommended for air treatment only.

Table 1: Corona Discharge Method and UV Method - A General Comparison

As expected, the solubility of ozone increases with an increase in ozone concentration in the gas stream. According to Henry's Law, the efficiency of absorbing a specific gas into an aqueous phase is based on the partial pressure of that particular gas in the total gas flow. Therefore, the higher the concentration of ozone in the generator gas stream, the more complete will be the transfer of ozone into the water. For UV generated systems, the ozone solubility is nearly nil. Hence, for ozone treatment of swimming pools, CD generated ozone will provide a water quality that is not achievable with UV generated ozone.

From a scientific and regulatory perspective water disinfection is routinely characterized on the basis of contact time as ascertained by Chicks law. Contact time and its kinetics are simply a measure of the inactivation expressed as a function of concentration of the disinfectant and time (as C^*t , C is residual concentration, and t , time). As expressed earlier, the concentration of ozone through UV generation method is 1/20 that of CD generation method. In addition to this, most UV lamps used for disinfection purposes operate in the 254 nm range. The ozone produced in the process gets decomposed by UV radiation to form hydroxyl radicals. The half-life of hydroxyl free radicals is on the order of microseconds and have very little time to complete disinfection action which typically require longer contact times. As a result hydroxyl radicals have oxidizing properties, but no disinfection property. On the other hand, corona discharge method of ozone generation produces a mix of molecular ozone which has excellent disinfection properties due to longer half life and hydroxyl radicals with shorter half life with excelled oxidizing property as well.

Hence, UV generated ozone systems are not recommended for swimming pool applications where disinfection is of primary importance (in India).

UV generated ozone systems are primarily used for air applications like deodorization and disinfection where traces of ozone is sufficient. Any application that requires more than trace quantities and concentrations of ozone will necessarily opt for corona discharge method of generation.

UV generated ozone systems are quite popular in America because of the

inherent high quality of water that typically require lower disinfection doses. In addition to this, trace quantities of ozone generated through the UV method do not act as a primary disinfectant, rather helps polish the water (odor and color) and disassociate Bromide salt to Hypo bromous acid and liberating bromine gas which act as the primary disinfectant. (In the US bromine gas is more popular than chlorine and less harmful).

The Future

Once pool owners switch to ozone, they realize that they no longer have to put up with red eye, rashes and the health consequences of chlorinated pools. Without a doubt, ozone starting to gain a foothold in water treatment and for swimming pools. Most major pool operators across the world use ozone technology. Every single International games pool is ozonized. As these technology leaders continue to push for alternatives to chlorine, acceptance of this technology will be more and more favorable. But designing the ozone dosage, the ozone concentration and the method of dissolution will decide the efficiency of ozone in swimming pools. With proper design, swimming pool owners and users can enjoy all the benefits of ozone while saving on water and chemicals.

About the Author

Shreyas B. is an alumnus of BITS, Pilani and IIMA. He had joined Ozone Technologies and Systems India Pvt. Limited Chennai in the year 2009. He has received intensive training under some eminent ozone specialist and from Xylem Water Solutions Inc. He is now a Director of the company.

Ozone Technologies & Systems (India) Pvt. Ltd. more popularly known as OTSIL was formed in May 1994. Over the last 15 years OTSIL had been promoting the use of ozone. Starting off with simple applications such as water treatment, OTSIL has expanded its application reach to more complicated process such as ozonolysis and pulp and paper bleaching. Today OTSIL is known for its expertise in many ozone applications and have more than 600 installations all over the country. To the prospective ozone users in India, OTSIL provides a vast range of equipments, starting from small 3 gram unit to the Jumbo sized 200 Kg per hour.

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