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Pool Tip #54: Ozone Generators

Ozone is activated oxygen or O_3. Ozone was named by C.F. Schoenbein in 1840, and its name is derived from the Greek word "ozein" which means "to smell".

Ozone was first used for drinking water disinfection in 1893 in Oudshoorin, The Netherlands. Nice, France began disinfecting its public water supply in 1906 and still does today. Potsdam, New York was the first U.S. city to treat its drinking water with ozone. The largest ozone generation plant in the world is in Los Angeles. The L.A. plant can treat as much as 600 million gallons of water per day. Ozone is also use to treat air, and sewage.

Pool disinfection with ozone has been common in Europe since the 1950's. A swimming pool ozone system was displayed at the 1939-1940 New York World's Fair. The first pool in the U.S. to use CD (corona discharge) ozone to treat its water was the Lake Mohawk Cruiser Swim & Tennis Club in Byram, New Jersey. The system was installed in 1937.

Two common methods of producing ozone on-site for swimming pool and spa water oxidation and sanitation exist.

In the ultraviolet light method of ozone generation, air is passed near special mercury vapor UV lamps made of quartz glass that produce light of a specific wavelength. Oxygen molecules, O_2, are bombarded with UV rays and recombine into ozone, O_3, but in very low concentrations.

In the side stream, corona discharge method, the preferred method of generating ozone on-site for pool water treatment, air is first oxygen enriched then dried to prevent nitric acid from forming. The oxygen enriched, dried air is then sent past a di-electric or high voltage electrodes, which give off a bluish glow or “corona discharge”. O_2 is split into individual oxygen atoms which recombine into O_3. The ozone is then injected through a venturi and transferred into a side stream of water drawn off the pool water return line. Corona discharge ozone systems should also include the use of contact chambers and may include degassing units similar to those used in the larger and much more expensive European model ozone generation systems, to treat pool water and remove the ozone from the water prior to its entering the swimming pool.

The goal of side stream sizing is to achieve one complete turnover of water in a given period, or to cause all the water in the pool to be ozonated at a given percentage of side stream. Volume of the pool in gallons is divided by the time factor in minutes in a day, and then by the actual flowrate in gallons per

minute. For example, a pool containing 95,000 gallons of water divided by 1,440 minutes in a day divided by a flowrate of 265 gpm (a typical 6 hour turnover rate), equals 0.248. Therefor, a minimum 25% side stream is required. The side stream is usually sized at between 25 and 33 percent, however, if you reduce the side stream, the dose concentration goes up inside the contact chamber.

Ozone generator sizing is based on the formula "___ gallons per minute multiplied by 0.227 grams per gallon multiplied by 0.4 milligrams per liter equals ___ grams per hour". Derivation of the 0.227 conversion constant for use in calculating ozone generator size is based on water flow rate, gpm times Xμ times ppm = grams per hour. Xμ equals grams per hour times minutes per gallon. Xμ equals 60 minutes per hour times grams per gallon. 1 ppm is equivalent to 1 milligram per liter which equals 0.00379 grams per gallon. Therefore, X = 0.00379 grams per gallon times 60 minutes per hour, or X = 0.2271 grams per gallon.

The goal of contact chamber sizing is to achieve enough contact time between the ozone produced and water in the side stream to allow at least 4 minutes of retention of the side stream flow in a contact chamber, tower, or vessel, and an ozone dose of 1.6 ppm in the side stream when ozone is the primary oxidant. CT values of at least 1.6 are achieved when the concentration of ozone in milligrams per liter equals 0.4 for a time of 4 minutes. Flowrate in gallons per minute is multiplied by 4 minutes to determine the minimum size of the contact vessel in gallons.

When sizing ozone generating systems for different types of facilities with different user profiles and characteristics, it becomes obvious that one size does not fit all. When comparing units for purchase, ask the manufacturer to provide an individualized report recommending a generator size based on grams per hour and pounds per day of ozone production, as well as the parts per million dose on main filtration. Side stream in gallons per minute and percentage of main flow should be provided along with electrical specifications, oxygen feed gas flow, and cooling water requirements. Contact tank, degassing valve, ozone destruct, injector, booster pump and ambient ozone monitors models and sizes should also be suggested.

Ozone is an excellent oxidizing agent--thousands of times faster than chlorine or bromine at removing organic and inorganic contaminants and pathogens from the water. Organic contaminants such as perspiration, urine, creams, ointments, hair care products, cosmetics, nasal secretions, and creatine (a chemical normally found in blood and excreted into urine by the kidneys) are partially oxidized by ozone, reduced to nitrates, or flocculated and removed by the filters. Ozonated pool water will not foam, because ozone destroys foam causing organic compounds. Ozone will remove organic material before chlorine can react with the organics and help prevent the formation of carcinogenic substances called trihalomethanes (THM). No PCBs (polychlorinated biphenyls) form during ozonation, and ozone itself is not carcinogenic.

Elite level competitive swimmers believe they can swim faster in an ozonated pool. Swim event times can drop because of the decreased friction resulting from more complete oxidation and increased oxygen levels in the water.

Disease causing bacteria, waterborne viruses, yeasts, protozoa, cysts, parasites, spores, and amoebas can all be destroyed by ozone depending on the contact time and concentration of ozone in the water. Ozone is drawn to bacteria and explodes bacteria walls on contact.

Because ozone is only being generated when the pool water is circulating, and ozone leaves no residual for killing bacteria about to be introduced into the water, it must be used in conjunction with chlorine or bromine if continuous disinfection of pool water is desired. However, use of ozone results in a reduced halogen consumption. Less bromine or chlorine are needed to maintain the oxidation reduction potential (ORP), and lower halogen residuals are required. Ozone does not dry skin, or bleach swimmers' hair. For swimmers with halogen sensitivities, contact dermatitis problems and the resulting skin rashes will be reduced.

Ozone helps prevent formation of chloramine compounds. Eye, sinus, mucous membrane and throat irritation from chloramines are eliminated. No objectionable odor is produced. Ozone is often described as smelling "like watermelons". Ozonated pools will only occasionally need to be shocked or superchlorinated.

Ozone will floc particulate matter increasing filter effectiveness, and the water will appear clearer, due to removal of finely suspended colloidal particles. Ozone does not contribute to the total dissolved solid (TDS) build-up, and may actually reduce the TDS because of particle coagulation. Therefore, less frequent draining and refilling of the pool is required.

Ozone is safe and inexpensive to use once the generating system is installed. Since ozone is generated on-site, from oxygen in the air, as needed, there is less storage and transportation of large quantities of hazardous materials. Ozone in pool water is not explosive and is not flammable. Ozone injection lines are under vacuum. If a leak in an ozone line should occur, air would leak into system rather than ozone leaking into the air.

Ozone helps remove metals which can discolor water and stain pool surfaces, prevents calcification, and softens the water. Ozone has no effect on pH or total alkalinity, so fewer chemicals are needed to adjust pH and water balance. Ozone destroys oils and converts them to carbon dioxide (CO_2). The use of enzymes to remove oils is not necessary and bathtub ring formation at the waterline will be reduced.

When properly sized and installed, a corona discharge ozone generation system should result in easier to maintain, less costly, and better smelling, better tasting, and better quality pool water.