Computer Modeling for Ozone System Sizing

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An industry problem currently exists in which some manufacturers are significantly undersizing or oversizing ozone systems based on owner budget. This is leading to much confusion, and a perception by many that ozone "doesn't work". Software was developed to provide the industry with a standardized method of sizing side stream (slip–stream), corona discharge ozone systems for swimming pools, spas, and recreational water features.

The software package, trade–named "DEL Pro3 Size™" will allow manufacturers to compete equally in the marketplace. The end users will be able to select a system based on generator size and output, rather than being influenced by a charismatic salesperson only concerned with making the sale and pushing his or her product over the actual needs of the customer. They will be able to compare "apples to apples" when shopping for an ozone generating system. Informed consumers will hopefully be able to select a system that will meet their facility's needs, and that will achieve the goal of keeping the pool water properly sanitized and oxidized.

The software takes into consideration several factors which influence the amount of ozone that is needed to meet the needs of the facility, including: the facility type and pool location, the owner's motivation for wanting to install an ozone system, pool volume, the average daily bather load, and more importantly the bather load to water volume ratio, the temperature at which the water is typically maintained, the flowrate and turnover time, and the type of filter media, filter area, and filter design flowrate. The software also gathers information on the facility contact person, demographic information, the age of the facility, the chemical use profile of the pool including chemicals, the chemical feed system and controllers used. The software will flag items which are significantly out of range, so that pool owners can be alerted to problems that won't be improved simply by installing an ozone system.

The software is available in CD-ROM format and available for use on the IBM compatible PC platform. The target market for distribution of the software is architects, aquatic consultants, pool contractors/builders, and commercial aquatic facility owners.

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 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

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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. Therefore, 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". The software's formula takes volume in gallons and divides by contact time in minutes, multiplies by the 0.227 conversion factor, then multiplies by an assigned motivational factor, temperature factor, location factor, and ozone factor (bather load divided by flowrate). Derivation of the 0.227 conversion constant for use in calculating ozone generator size is base 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.

As can be seen 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 (see Table 1).

The software will prepare and allow the customer to print out 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 are 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 are also suggested.

The software's development goals will be met when facility owners realize that proper sizing and installation of their corona discharge ozone generation system has led to easier to maintain, less costly, and better smelling, better tasting, and better quality pool water; and pass the word on to other potential customers.

About the Presentor

Alison Osinski, Ph.D. has received degrees from the University of Maryland (Ph.D.), Florida International University (M.S.) and Hillsdale College (B.S.) in Physical Education with a specialty in Aquatics. She is actively involved with several national and regional aquatic organizations, and currently serves as an officer or advisory board member for many organizations, including the National Swimming Pool Foundation (NSPF), the Professional Pool Operators of America, and the International Association of

	Swim School	Leisure Facility	Therapy Pool	Multi-Use Pool	Spa
Use	Instruction	Recreation	Therapy	Recreation / Competition	Soaking
Motivation	All	Water / Air quality	All	Water / Air quality	All
Bather Load Per Day	280	1,500	200	500	100
Water Temperature	92° F	83° F	90° F	84° F	104° F
Volume	19,170 g	274,828 g	81,033 g	240,700 g	3,500 g
Flowrate	320 gpm	1,145 gpm	644 gpm	668 gpm	116 gpm
Location	Indoor	Outdoor	Indoor	Outdoor	Indoor
Bather Load :Water Volume	1:60	1:165	1:405	1:481	1:35

Table 1

Aquatic Consultants. Her experience includes past employment as a lifeguard, swim instructor, swim and crew coach, pool service technician, and university professor, prior to starting her consulting firm, Aquatic Consulting Services, in 1982. She is the author of over 65 publications, and is a frequent speaker at national aquatics conferences. She runs the "Swimming Pool Hotline" and has a regular column entitled "Information Please" in *Pool & Spa News*.