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# Journal of the **S**wimming **P**ool and **S**pa Industry

J. Que Hales, Editor

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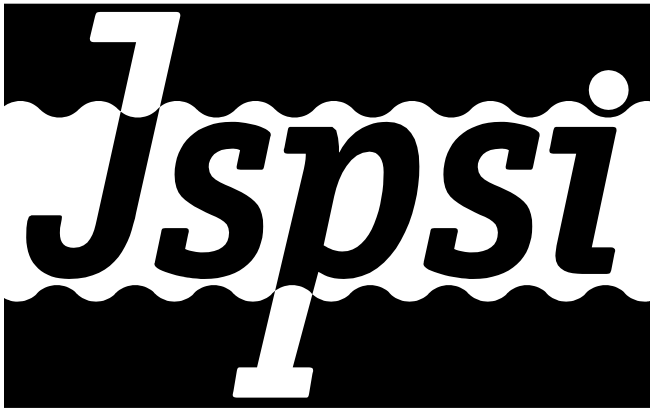
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**Journal of the Swimming Pool and Spa Industry**

*The Journal of the Swimming Pool and Spa Industry (JSPSI)* publishes papers on all aspects of the swimming pool and spa industry. Research, informative papers, bibliographies, book reviews, and symposia-in-print are presented for the general education of all technically minded individuals in the industry.

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# The people behind *JSPSI*:

## Editor

The Editor of the *Journal of the Swimming Pool and Spa Industry* is J. Que Hales. He is currently employed by Pool Chlor, a residential gas chlorine chemical service firm. He has been in the pool industry since 1980, working first as a residential chemical technician, and then as the owner of a small independent cleaning, repair, and retail business. He has managed the Tucson office of Pool Chlor since 1985, and also functions as the Pool Chlor corporate computer systems manager and mailing operations manager. He studied English and Secondary Education at the University of Arizona. He is the co-author of several technical papers which have been reported on in various industry magazines. He has been a member of the Board of Directors of the National Association of Gas Chlorinators (NAGC) since its inception, and is currently the Vice-president/President-elect of that organization, as well as Editor of its bimonthly newsletter. He is also a member of the Board of the Southern Arizona Chapter of the National Spa and Pool Institute (NSPI), and currently serves as the secretary of that chapter.

## Editorial Advisor

The advisor to the editor on Journal management and editorial policy is Lyn Paymer of Association Services in Trabuco Canyon, California. Lyn is currently the Executive Director of a number of industry associations, including the National Plasterer's Council (NPC) and the NAGC.

## Editorial Review Board

The Editorial Review Board is a group of volunteers who have agreed to read and referee submissions to the Journal. In order to maintain an objective, independent Journal, the Editor does not determine which submissions will be published and which ones will not. The Review Board, comprised of a wide selection of professionals in the publishing, technical, and service facets of the industry, performs a blind review, meaning that the Editor removes the cover sheet and other identifying text before the Board members see the submission. They then judge suitability based on sound scientific method, clarity, readability, pertinence to the industry and the Journal, etc. Each submission is reviewed by at least three individuals, two of whom must be Board members, and one of whom may be selected as needed from the

industry at large for particular expertise on a specific subject. Board members do not know which other members are reviewing a particular submission, and if a Board member chooses to abandon anonymity to contact a particular author for clarification, he/she will not compromise other reviewers (if known).

These Review Board members, along with the advisor to the editor, deserve our special thanks and appreciation. The *JSPSI* is a non-profit publication, and these individuals donate their time and efforts on our behalf. In subsequent issues they will be listed, but without full biographic information. We would like to take this initial opportunity, however, to introduce them (in alphabetical order):

**C. Brent Cluff, Ph.D.** did his undergraduate studies at Eastern Arizona College and the University of Arizona, received his BS and MS from the University of Arizona, and received his Ph.D. from Colorado State University. He is currently the owner/principal of Clean Water Products in Tucson, Arizona. He recently retired, after 32 years, from his position as an associate hydrologist with the University of Arizona.

**Fernando del Corral, Ph.D.** is a Research Microbiologist and is the Manager-Product Development, Recreational Water Research and Development Department at Buckman Laboratories, International. He studied at Southwest Baptist University (BS - Bacteriology and Chemistry), and the University of Georgia (MS and Ph.D. - Bacteriology). Dr. Corral is the author or coauthor of numerous publications, and has many patents, committee memberships, and professional association memberships to his credit.

**Gerald Eckels** is the principal of Kruger & Eckels, a Santa Ana, California-based manufacturer of swimming pool and spa controllers and meters. Formerly with Southern California Gas Company, he joined Kruger & Eckels in 1972. Kruger & Eckels provides custom engineered instrumentation that has been used in research, and distributes its products internationally.

**Randy Golding, Ph.D.** is a chemist at Tracer Research in Tucson, Arizona. Formerly a post-doctoral fellow at Lawrence Livermore Laboratories, Dr. Golding received his

undergraduate degrees (BA – Education, BS – Chemistry) from Arizona State University and his Ph.D. in Analytical Chemistry from the University of Arizona. He has consulted for a number of swimming pool chemical research projects.

**Eric Herman** has been the Technical Editor for *Pool & Spa News* since 1989. He was graduated from California State University at Fullerton with bachelor degrees in Journalism and English. Eric has published over 100 articles, many of the technical in nature, in various publications, including *Pool & Spa News*, *Technical Resource Magazine*, and the *Sound and Video Contractor* trade journal.

**Ron Jones** has been in the swimming pool industry for 13 years, and was the Senior Research Scientist with BioLabs. He holds 3 patents, and has 7 pending on various water treatment applications, and does private consulting as Chemical Specialties in the areas of swimming pool and spa chemistry as well as industrial water treatment. He received a BS in Chemistry from the University of Georgia, and has served on the Chemical Treatment and Process Subcommittee of the NSPI.

**Dave Knoop** is the Applications Manager of Pool Products at Olin Research Center. He works with customers and consumers on product application issues, as well as being involved in field evaluation of new products. He has authored articles in both the trade press and the public media. Dave was graduated from the University of Wisconsin, with BS degrees in chemistry and biology. He is the former chairman and a current member of the NSPI's National Education Committee, which produces and administers the NSPI Tech program.

**Doug Latta** is the owner/principal of Aqua Clear Pools Inc. of Chatsworth, California. He studied at California Lutheran University (BA – Business) and California Coast University (MBA). He is a licensed swimming pool contractor, as well as a general building contractor in the state of California. He is a published author, and is the founding and immediate past president of the NAGC, a member of the board of the Swimming Pool Chemical Manufacturers Association, and the current president of the Swimming Pool Trades and Contractors Association, a California-based safety, education, and support association.

**Peter S.K. Lee, Ph.D.** studied at Adrian College (BS – Biology), and the University of Houston (MS –

Microbiology, Ph.D. – Biochemistry). He is currently the Senior Development Biologist with Zeneca Pool Products. He is the author and co-author of many technical papers, and has received specialized training in many fields including air quality and industrial water process treatment. He is particularly interested and involved in microbiological risk assessment, and the development, evaluation, and application of disinfectants and algaecides for swimming pool and spa use.

**R. Neil Lowry, Ph.D.** is a graduate of the University of Western Ontario in Honors Chemistry and received his Doctorate in Inorganic Chemistry from Cornell University. Being in the pool industry since 1977, Dr. Lowry has published extensively in industry trade journals and holds an annual 3-day course on pool water chemistry. He is also a member of the NSPI's Chemical Treatment and Process Committee and has given several talks at past NSPI trade shows. Dr. Lowry is a consultant to governments and numerous corporations in the areas of label registration, chemical formulations, marketing and text writing. He was contracted by Agriculture Canada to standardize all pool chemical labels falling under the Pest Control Products Act of Canada. More recently Dr. Lowry created Spa Water Standards for commercial spas under the jurisdiction of the Ontario Department of Health.

**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 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*.

**Rip G. Rice, Ph.D.** is president of RICE International Consulting Enterprises, a consulting firm which

was established in 1972. He is a cofounder of the International Ozone Association (1973), and is Editor-in-Chief of Ozone: *Science & Engineering* and *Ozone News*, which are the journal of the IOA, and its bimonthly newsletter, respectively. Dr. Rice has authored or coauthored many papers describing the chemistry of ozone with respect to pool and whirlpool water treatment, and prepared the final draft of the Recommended Code of Practice for Public Spas using Ozone for the National Environmental Health Association (June 1989). Since January 1992, Dr. Rice has been a member of the National Spa & Pool Institute (NSPI) Chemical Treatment and Process Subcommittee of the NSPI Technical Council.

**Margis Robinson** is the president of Memphis, Tennessee-based Bio-Chem Associates, Inc., a consulting firm specializing in swimming pool water chemistry-related problems, and the

treatment of water and wastewater. He has been involved in the pool industry for over 22 years, and is the author of a book and also of articles in various trade journals. He was graduated from Samford University with a BS in chemistry, and has been professionally involved in many industries, including terms as technical director and project engineer of several space shuttle projects.

**Kim Skinner** is the co-owner of Pool Chlor, a chemical service firm with offices throughout the Southwest. He joined Pool Chlor in 1974. Kim has worked in the swimming pool industry for 25 years, and is a former manager of Skinner Swim Pool Plastering, Inc. of Sun Valley, California. He is the co-author of several technical reports on swimming pool water chemistry and plaster phenomena, which have been featured in articles in the trade press. A speaker and panelist at various trade conventions, Kim is also involved with the NSPI, the Chlorine Institute, and the NAGC.

# Sanitizer Chemistry

## A Technical Symposium

Co-sponsored by the Journal of the Swimming Pool and Spa Industry and the Western Pool and Spa Show

The symposium is scheduled to begin at 10:00am, Wednesday March 6th, and conclude at 5:00pm that evening. Papers presented will be published in the Spring and Summer issues of the Journal.

### Keynote

**Professor Charles Gerba, Ph.D.**

**University of Arizona**

Dr. Gerba's keynote address will focus on the area of microbiological concerns in swimming pools and spas. Dr. Gerba is a leading authority on disease-causing organisms and methods for their inactivation. Dr. Gerba has over 350 scientific publications to his credit, and is actively involved with the U.S. EPA on microbial issues in water.

### Abstracts

**(in alphabetical order by author)**

**Brian C. Bokowy**

**BioLab**

*The Chemistries of Bromine for Pool and Spa Water Treatment*

The bromination of pool and spa water has long been recognized as an effective method of sanitization and as an alternative to chlorine based sanitation systems. The chemistries of bromine sanitation and hypobromous acid are discussed with respect to pool and spa water treatment. The use of 1-Bromo-3-Chloro-5,5-Dimethylhydantoin is the most common method of bromination of pool and spa water. Most commonly referred to as BCDMH, 1-Bromo-3-Chloro-5,5-Dimethylhydantoin presents unique chemical and physical properties that make it an effective pool and spa sanitizer. The physical properties of BCDMH are discussed in addition to methods of product application. A description of bromine-ozone chemistries and their significance in pool and spa water treatment is also included.

**Allen Clawson**

**Beth Hamil**

**DEL Industries**

*Corona Discharge Ozone Systems Application Guidelines for Commercial Pools and Spa Pools*

Successful application of an ozone system on commercial pools and spa pools can only be accomplished when the following charter is maintained:

**Install an ozone system that provides the highest oxidation and disinfection of water while ensuring that no ozone enters an area where humans, equipment, or the environment are endangered.**

There are varied opinions on the best way to address ozone system and reaction tank sizing for commercial pools and spa pools. Historically, in the U.S., these guidelines have been vague or non-existent regarding the application of ozone on commercial pools and spa pools.

The paper presents basic system design and application with a complete set of guidelines from sizing formulas to safety issues.

**Wolfram Hartwig, Ph.D.**

**Engineered Treatment Systems**

*To DIN or Not to DIN: Ozonation of Pool Water in Public and Commercial Pools*

The German pool code, DIN 19643, is a comprehensive standard that regulates all aspects of pool design. It includes ozonation as part of the disinfection and treatment of the pool water. Compliance is mandatory in some, but not all, European states. Health officials and pool designers in many countries around the world, where ozonation is not covered by existing codes, have accepted DIN 19643 as a guideline.

The paper presents some of the basic design concepts of DIN 19643, with emphasis on the ozona-

tion parameters. These are contrasted with U.S. designs, in process applications that employ pre-filter or post-filter injection and full flow or side stream ozonation. Results from several selected sites demonstrate the successful elimination of pool water problems. Recommendations include a list of suggested design dosages based on observations, and additional ozonation design criteria.

**John Rafter**

### **Fountainhead Technologies**

*Determination of Anti-microbial Synergy in the Monopersulfate/Silver Ion System*

The bactericidal effect of silver ions in solution has been known for centuries and used to that effect in medicine and water treatment. The disinfection rate of silver ions at low concentrations (less than 0.1 ppm) versus the sanitary index organism *E. coli* is significant but relatively slow. It has been established that a synergy exists between silver ions at low concentration and potassium peroxymonosulfate to enhance the rate of silver ion disinfection.

**Rip G. Rice, Ph.D.**

### **Rice International Consulting Enterprises**

*Chemistries of Ozone for Municipal Pool and Spa Water Treatment: Facts, Fallacies, and Current Concerns*

Ozone generated by ultraviolet (UV) radiation is used in North America for treating (mostly residential) spa and pool waters almost exclusively, while only a handful of North American municipal pools and spas are using ozone generated by corona discharge technology in accordance with well-established German teachings. On the other hand, several thousand European municipal swimming pools and spas are using corona discharge-generated ozone today at concentrations which cannot be generated effectively by UV radiation in quantities sufficient to perform simultaneous oxidation and disinfection.

To apply ozone efficaciously and cost-effectively for the treatment of municipal pool and spa waters, an understanding of its chemistry in water is essential, particularly with respect to those human-supplied contaminants and chemical additives encountered. The pertinent chemistries of ozone are discussed in this paper with respect to the major constituents of pools and spas it is likely to encounter. The numerous technological advantages of ozone generated by corona discharge versus UV radiation also are discussed, including the use of ozone to produce hypobromous acid *in situ* from bromide ion charged to the pool waters.

Several examples of North American municipal swimming pool installations using ozone according to European teachings are described. Also, current issues of interest in the ozonation industry will be discussed.

**Jacques M. Steininger, D. Eng. Sc.**

**Santa Barbara Control Systems**

**Catherine Pareja, Eng. Tech.**

### **Institut Universitaire Technologique de Nancy-Brabois, France**

*ORP Sensor Response in Chlorinated Water*

Proper maintenance of pool or spa water requires careful monitoring of the pH and sanitizer levels. In the past, the sanitizer concentration was tested with OTO or DPD test kits. The advent of chemical automation in recent years has introduced the use of the ORP sensor to measure the Oxidation-Reduction Potential generated by the sanitizer in the water.

While many studies have shown that ORP measurements in pool and spa water are very effective in monitoring the activity of the sanitizer (chlorine, bromine or ozone), very little information has been presented on the response of the ORP sensor as a measuring instrument. In this study, the response time and reproducibility of commercially available ORP sensors were determined and compared to amperometric, colorimetric and DPD test kit measurements.

The effect of the Total Dissolved Solids concentration (TDS) on ORP sensor readings was determined for sodium Chloride (NaCl) concentrations between 0 and 3,500 ppm (mg/l). The ORP sensor response curves for chlorine concentrations between 0.2 ppm (mg/l) and 12.5 ppm (mg/l) and for pH values between 6.5 and 8.5 were redetermined under controlled laboratory conditions and compared with earlier published data.

**Michael J. Unhoch**

**Roy D. Vore, Ph.D.**

**Peter S. K. Lee, Ph.D.**

### **Zeneca Biocides - Chemical Research and Development Laboratory**

*Stability of Swimming Pool/Spa Sanitizers: Comparative Chemical Stability of Polyhexamethylene Biguanide and Hypochlorous Acid*

Proper hygienic conditions in swimming pools and spas are dependent on the maintenance of a minimum level of disinfectant. The two most common disinfectants in swimming pools are

polyhexamethylene biguanide (PHMB) and chlorine (HOCl). The stability of PHMB and HOCl were compared over the range of temperature, pH, organic load, and sunlight that occur in typical pools and spas. The concentration of bioavailable PHMB was unaffected by temperatures between 39°F and 108°F, pH values between 6.2 and 10.0, and organic load. The quantity of the HOCl available for disinfecting purposes was significantly affected by shifts in temperature and pH. In the presence of ammonia HOCl was converted to less active chloramines. PHMB was not depleted under artificial sunlight levels that caused rapid depletion of HOCl. In practical terms, the PHMB concentrations should be monitored weekly and dosed when the active level falls below the recommended level of 6 ppm. The instability of HOCl mandates that testing and adjustments of levels be performed on a daily basis and, depending on which form and feeding system is used, maintained between 3 and 5 ppm.

## **John A. Wojtowicz**

### **Chemcon**

#### *Relative Biocidal Effectiveness of Hypochlorous Acid and Chloroisocyanurates*

Earlier laboratory studies showed that, although cyanuric acid stabilizes available chlorine against photochemical decomposition, it reduces the effectiveness (i.e.: deactivation/kill rate) of available chlorine as a disinfectant against bacteria such as *E. coli* and *S. aureus*. This was attributed to the formation of chloroisocyanurates which, although more stable to sunlight, were thought to be less efficient biocides than hypochlorous acid.

A determination of all thirteen equilibrium constants for the cyanuric acid–available chlorine system now allows calculation of the free hypochlorous acid as a function of pH and the concentrations of cyanuric acid and total available chlorine. Vapor–liquid equilibrium measurements on aqueous chloroisocyanurate solutions were in good agreement with calculated hypochlorous acid concentrations.

A computer program was employed to calculate the concentrations of hypochlorous acid as well as the various chloroisocyanurates in the published experimental data on the effect of cyanuric acid on the kill time of bacteria by available chlorine. Statistical analysis was utilized to evaluate the relative efficiency of hypochlorous acid and chloroisocyanurates. It showed that killing/deactivation of bacteria was due essentially entirely to hypochlorous acid. Data for stabilized and unstabilized conditions gave similar results.

Although chloroisocyanurates are relatively ineffective biocides, they allow longer term disinfection in outdoor swimming pools compared to unstabilized available chlorine because they serve as a reservoir of hypochlorous acid – releasing it on demand via hydrolysis.

## **Perspective**

### **Anita Highsmith**

#### **Water Quality Laboratory – Centers for Disease Control**

A closing perspective will be offered by Anita Highsmith of the Centers for Disease Control, on issues involving the monitoring of outbreaks in swimming pool and spa waters.