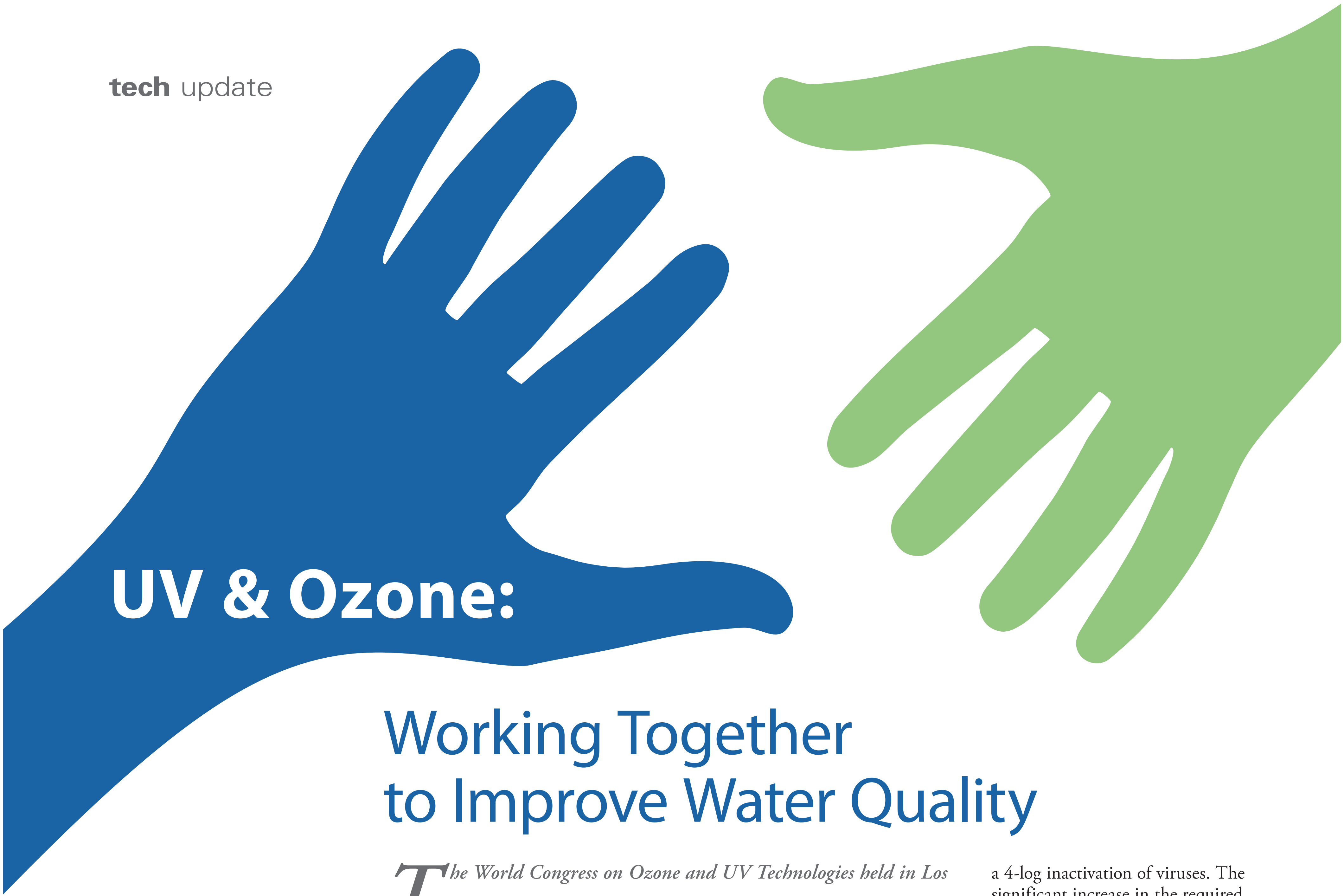

UV & Ozone:

Working Together to Improve Water Quality

By Ray Denkewicz

Old technologies produce new results

The World Congress on Ozone and UV Technologies held in Los Angeles in August 2007 provided industry-wide confirmation of what had become obvious to many: While ultraviolet (UV) and ozone are excellent stand-alone technologies, together they are a potent technology combination useful in addressing a wide variety of water quality issues.

Although UV and ozone have been individually employed as part of water treatment methodologies for decades, reports on the use of these two technologies in combination have been much more limited. Momentum appears to be building in the combined use of these two technologies with our improved understanding of the chemistry involved in their interaction as well as with the changing regulatory framework for drinking water quality.

Ozone to the Rescue

The promulgation of the final version of the Long-Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) in January 2006 has been one such driver for a review of UV and ozone disinfection strategies. In the LT2ESWTR, the U.S. Environmental Protection Agency (EPA) established guidance that requires an UV dose of 58 mJ/cm^2 for a 1-log virus inactivation credit, 134 mJ/cm^2 for a 3-log credit and 186 mJ/cm^2 for a 4-log virus inactivation credit. The required UV doses for virus inactivation were derived based on the UV dose necessary for the inactivation of the adenoviruses, currently the most UV-resistant set of waterborne human viruses known.

Prior to publication of the LT2ESWTR, a UV dose of approximately 40 mJ/cm^2 had been widely accepted in the U.S. as providing a 4-log inactivation of viruses. The significant increase in the required UV dose for viruses poses, in many instances, an economic challenge for utilities. This economic burden will extend to some groundwater treatment facilities where virus inactivation will be required under the U.S. EPA Ground Water Rule. Fortuitously, adenoviruses are readily inactivated by ozone with CT values as low as 0.07 mg-min/L for a 4-log inactivation.[1] In light of this, the combined use of ozone with UV may be a viable and safe water treatment strategy that utilities could employ to achieve desired reductions in pathogenic microorganisms.

UV to the Rescue

Ozone technology has been an important treatment strategy for taste and odor control in drinking water for some time, and its use in the oxidation of emerging contaminants such as endocrine disruptors has garnered significant attention. Ozone is generally not employed as a stand-alone primary disinfectant but it can be used as part of an overall disinfection strategy. Bromide-containing waters can limit the use of ozone, however, owing to the fact that bromates, a regulated disinfection by-product (DBP), are produced. Some researchers and utilities have demonstrated that the dual use of UV and ozone can affect the necessary taste and odor control while producing lower bromate concentrations.

Utilizing a UV treatment step after ozonation serves to promote the formation of hydroxyl radicals (a short-lived, potent oxidizer), resulting in a sufficiently different set of chemical interactions that result in less bromate. The combined use of UV and ozone, therefore, may be a viable water treatment strategy that utilities could employ to achieve desired taste and odor control while mitigating undesirable DBPs.

But is there Synergy?

Scientific literature can be found that supports either side of the debate regarding synergistic effects of combining ozone and UV. In these investigations, the varying UV and ozone conditions employed, as well as the plethora of water quality scenarios examined (i.e., microorganism and chemical loadings), do not permit a straightforward review of the subject.

In studies performed at the University of Arizona Water Quality Center, a synergistic action was noted with *Adenovirus 2*, *Feline calicivirus* and with *Naegleria fowleri*, but not with MS-2. Magbanua et al (2006) demonstrated a synergy when *E. coli* was used as the target organism.

Although the disinfection mechanisms of UV and ozone are uniquely different, the role of hydroxyl radicals in the disinfection process is not entirely clear. What is clear, however, is that there is a lot more to be learned about the benefits associated with the combined use of UV and ozone. The 2007 World Congress on Ozone and UV Technologies was an excellent start to our improved understanding of the potential benefits that exist with the combined use of these two technologies—technologies that have been with us for decades yet remain surprisingly foreign to us still. *wqp*

References

[1] Enriquez, Thurston, J.A., Haas, C.N. and Gerba, C.P. 2005. *Inactivation of enteric adenovirus and feline calicivirus by ozone.* Wat. Res. 39 (15): 3650-3656.

[2] Magbanua, B.S., Sauvant, G. and Truax, D.D. 2006. Combined Ozone and Ultraviolet Inactivation of Escherichia coli. *J of Env. Sci. and Health*, Part A, 41 (6): 1043-1055.

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