QUALITY HELP

Understanding UV and ozone and how these supplemental products are tested for efficacy and performance can help you maintain better water quality

Ozone and UV can work independently or synergistically to provide intense localized water treatment to help reduce the load on the chemical treatment systems. To better understand these complementing technologies, it helps to know their function and how they are tested and certified by NSF. With this information you will be better prepared to make decisions about facility design, treatment, and service.

Ozone and UV technologies are extremely effective at oxidation and disinfection and have been in use for more than 100 years in the water treatment industry. After some large spray-park and waterpark cryptosporidiosis outbreaks, regulations for cryptosporidium inactivation were drafted in some states. To address the need for consistency, NSF initiated development of harmonized cryptosporidium inactivation/killing requirements for drinking water and recreational water treatment systems.

What is Ozone and how does it work

Ozone is an unstable molecule of 3 oxygen atoms that quickly breaks down to O2 (oxygen). By it's very nature, ozone is a rapid and intense oxidizer of organic matter. It has powerful capacity, but a very short 'half-life'. Therefore ozone is not used as a traditional residual disinfectant, but has fast acting short half-life disinfection properties.

The ozone system consists of two basic components: an ozone generation system and an ozone management system. Ozone is a gas, which is traditionally dissolved and drawn into a side-stream of pool/spa water. The ozone system is designed to allow the ozonated water sufficient 'contact time' with the organic material, organisms, etc. in a mixing tank or engineered piping system.

The ozone generating system creates ozone gas. The ozone system dissolves the gas into the water, so no un-dissolved ozone is available to off-gas in the pool equipment room or at the pool water surface.

Typically an ozone management system utilizes an oxidation reduction potential (ORP) controller to monitor the proper ozone level in the water. The ozone is introduced after the filtration (and heater), and before the chlorine feeder. An ozone system's oxidation capacity enables properly sized systems to:

1. control the combined chlorine in water
2. increase the oxidation performance more that the residual disinfectants alone,

3 reduce the chlorine consumption while maintaining minimum residuals
4 produce a minimum 3 log (99.9 percent) kill of Cryptosporidium parvum, etc.
5 enable micro-flocculation to aid filtration and water clarity

NSF tests ozone generation system for aspects of safety and functionality including performance, effective mixing, disinfection efficacy, ozone output levels, ozone off-gassing potential, system life testing via testing 3 units for a minimum of 3,000 hours, etc.

How does UV work?

UV systems are designed to generate electromagnetic radiation or the ultra-violet light within the 200-400 nanometer wavelength range. Water is pumped through a reactor vessel where the UV light emitting lamps are separated from the pool/spa water by a protective quartz shield or sleeve. The quartz sleeve allows certain wavelengths of light to pass into the water where photo chemistry and photo oxidation may occur depending upon the wavelength of light, the energy level, the water chemistry and ultra violet light transmissivity level (UVT) and organism or material contacted.

The 200-400nm UV light range has 3 primary sub ranges of interest in water treatment, UVC-200-280nm (can be absorbed by organisms and damage genetic sequence encodings of RNA and DNA), UVB-280-315nm (infamous for links to skin burning and cancer), and UVA-315-400nm (famous for suntans). Within these ranges certain UV systems may focus a high level of output in a narrow range, or a broader distribution of energy with different energy peaks at different wavelengths.

There are different nanometer ranges of importance depending upon the contaminant or organism of concern in your treatment system. And different UV systems may consume more electrical energy or emit more photons of light energy within certain narrow or broad wavelength ranges. For most aquatic and recreational water users of UV, they are primarily interested in the ability of UV to perform 3 roles,

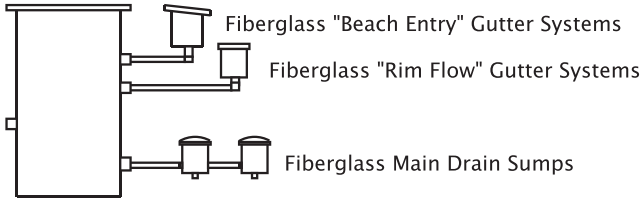
1 Inactivate of kill microorganisms (such as cryptosporidium)
2 Disassociate combined chlorine compounds (such as tri-chloramine or other DBPs)
3 Provide supplemental oxidation of organic matter to reduce load on the treatment system.

Essentially powerful electromagnetic radiation in the 'ultra-violet' wavelength range is used to damage inorganic and organic compounds as well as genetic material of certain organisms preventing them from replicating.

NSF evaluates, tests, and certifies that UV systems are effective at organism killing and inactivation via testing to NSF/ANSI Standard 50 requirements. NSF issued the final harmonized specific testing methods and evaluation criteria for third party testing and certification of UV systems. These requirements were added to the existing UV evaluation and testing requirements already within NSF/ANSI Standard 50. Thus the NSF Standard 50-2010 incorporated new requirements that include a more specific and repeatable derivative of the Long Term 2 Enhanced Surface Water Treatment Rules (LT2ESWTR) and United States Environmental Protection Agency Ultra Violet Disinfection Guidance Manual (USEPAUVDGM), as well as requirements from DVGW W-294 and ONORM 5873 for UV drinking water UV system evaluation criteria. The NSF 50 criteria for UV are summarized below:

- NSF 50 Section 3 Materials
- 3.2 Material formulation (health safety chemical and color extractants)
- 3.3 Corrosion resistance and other sections
- 3.4 Dissimilar metal

GRAVITY FLOW SYSTEMS



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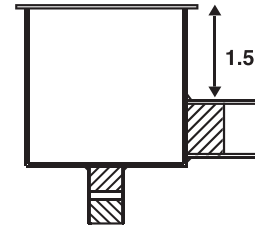

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Modification Risks to Ozone and UV systems

UV systems

- Don't modify-stay out of the power supply cabinet-Direct Current
- Flow, know your flow to ensure the product is rated-tested for conditions under which it's used
- Replacement sensors, or UVT monitors, changes to these components could compromise detected energy, and power delivery levels and treatment.
- Replacement lamps may not generate same wavelengths nor disinfection efficacy
- Beware low-med or amalgam lamp swapping. Each lamp type and system has different power supply needs and different radiation ranges.
- Replacement sleeves/shields may block more UV, ie less effective
- Replacement sleeves may foul more easily
- Note early burn-in first hours can result in erratic power output,

Ozone systems

- Don't modify-stay out of the power supply cabinet-Direct Current
- Ozone generation systems corona discharge/UV components are critical to system performance
- Ozone destruction or off-gasing systems (vent/carbon, etc)
- Ozone mixing tank/loop is used to ensure sufficient contact time to enable oxidation and disinfection prior to breakdown of O3 or off-gassing

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- 3.5 Insulating fittings:
- 3.6 Piping materials
- NSF 50 Section 4 Design and construction
- 4.1 Mechanical parts
- 4.2 Electrical components – installation and components comply with NEC/NRTL
- NSF 50 Section 11 General requirements for process equipment
- 11.3 Design pressure (pressure vessels)
- 11.4 Flow meter
- 11.5 Performance indication
- 11.6 Operation and installation instructions
- 11.7 Disinfection efficacy (minimum of 3 log kill, single pass, 5 cycles, of 2 bacteria [Pseudomonas aeruginosa & Enterococcus faecium] as tested via Annex H)
- 11.8 Valve and components identification, marking, piping diagram
- NSF 50 Section 13 Ultraviolet light process equipment
- 13.2 Operating temperature
- 13.3 Operational Protection (shielding and power cut to lamps)
- 13.4 Life Test of 3 units for at least 3,000 hours each
- 13.5 Cleaning and cleanability of the reactor/sleeves/sensor etc.:
- 13.6 Ultraviolet lamps
- 13.7 Chemically resistant materials
- 13.8 Data plate(s) marking requirements
- 13.9 Head loss or pressure loss testing
- 13.10 Hydrostatic pressure tesing requirements
- 13.11 UV Cryptosporidium parvum inactivation & dose determination

NSFs UV Crypto testing for UV systems

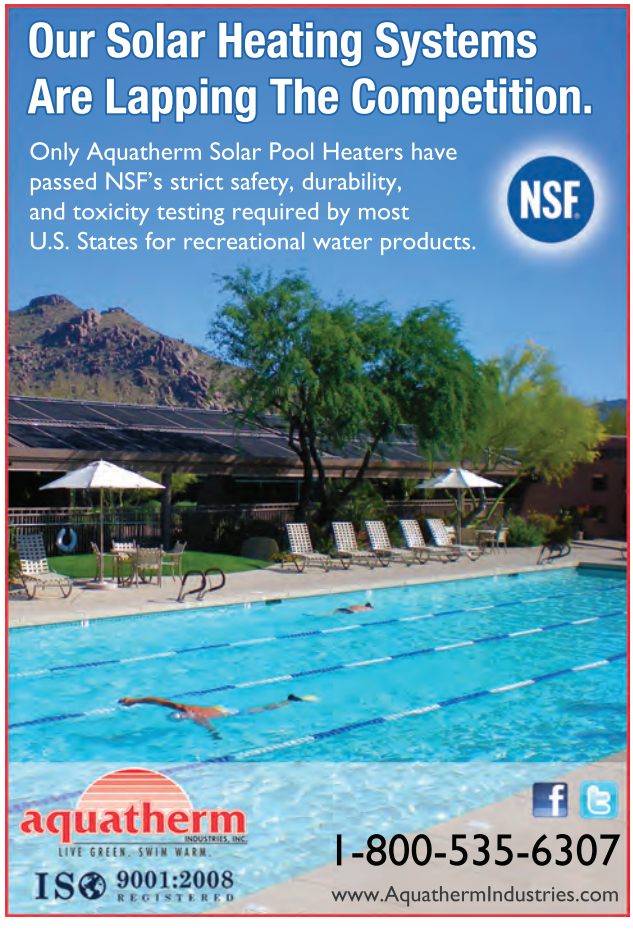
Crypto testing for recreational water use involves testing at NSF of a minimum 2 worst case systems within a product range (ie configuration L, U, etc, lowest power to highest flow, lamps, ballasts, etc. worst hydraulics via CFD, etc.) While NSFs testing for drinking water requires testing of each unit in a range.

- Validation of each model for a minimum 3-log of crypto inactivation performance
- Crypto inactivation testing to drinking water requirements in the USEPAUVDGM-2006 via testing to the 2010 NSF EPA ETV UV Protocol which is the harmonized testing criteria for Drinking and Recreational water uses.

Reporting of technical details about testing and system

- Model no.
- Max. Flow rate (or rates if set line approach testing is chosen)
- Achieved log reduction, (3+, 4, etc. log reduction)
- Effective dose delivered (mJ/cm2)
- Surrogate organism used for testing (MS2, T7, etc.)
- Specify required system minimum operating power level
  - Test reports contain details and data, UVT of water, etc.
- Testing may be set point, set line, or dose based
- Set line is best for dual use of Rec. and Drinking water facilities

You can find NSF Certified ozone and UV systems that comply with NSF/ANSI Standard 50 on NSF's listing Web page: *www.nsf.org/certified/pools*. For further information contact NSF International at *pools@nsf.org* or +1.734.769.8010. ■



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