Innovative Ultraviolet Light Source for Disinfection of Drinking Water

Phoenix Science & Technology, Inc.

27 Industrial Avenue
Chelmsford, MA 01824
Telephone: 978-367-0232
http://www.phoenixsandt.com

Environmental Problem

Water contamination causes a wide range of diseases. The main objective of disinfecting drinking water is to reduce the number of waterborne pathogenic organisms to safe levels and lower the risk of exposing the public to disease. Although disinfection methods range from chemical to physical, the many disadvantages of chemical disinfectants, specifically chlorine, have lead to increased interest and use of ultraviolet (UV) light as an alternative. The use of high doses of chlorine to disinfect water leads to the production of carcinogenic and mutagenic chloro-organics. These chloro-organics persist in the environment and are not destroyed by dechlorination methods that reduce chlorine residuals. Consequently, alternative disinfection techniques are becoming more widely used. Of the more than 200,000 community drinking water systems in the United States and Canada, more than 2,000 use UV disinfection systems.

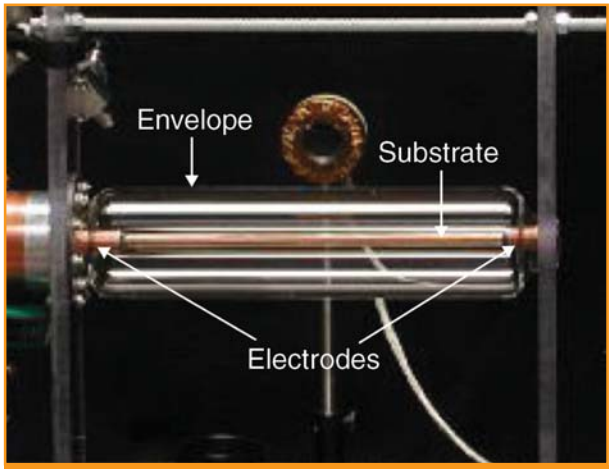
UV light disinfection is a well-established technology; mercury lamps have been commercially available for decades. The presence of mercury in these lamps, however, is an environmental concern. Additionally, the cost of the high doses of electrical power required to operate mercury UV lamps reduces the attractiveness of using this technology. A cost-effective, environmentally friendly method of disinfecting drinking water is needed.

SBIR Technology Solution

With support EPA's SBIR Program, Phoenix Science & Technology, Inc. (PS&T), demonstrated the efficacy of its patented pulsed "Surface Discharge" (SD) lamp to improve disinfection of drinking water. In an SD lamp, a high-power electrical pulse is discharged along the surface of a dielectric substrate, generating a light-emitting plasma along its surface. The SD lamp is free of mercury, a major concern with commercial UV lamps currently in use, and has a higher inherent UV efficiency than medium-pressure mercury lamps, so that electrical costs of a commercial system will be less.

UV light inactivates microorganisms by causing photochemical damage to nucleic acids. Absorption of UV energy, mostly in the 220-300 nm wavelength range, produces new bonds between adjacent nucleotides, creating double molecules or dimmers that prevent replication and result in cell death. The amount of cell damage depends on the dose of UV energy absorbed by a microorganism and its resistance to UV light.

Tests conducted as part of this SBIR project in collaboration with water treatment researchers at Duke University show that, in addition to higher UV efficiency, the SD lamp has a significantly higher inactivation rate, on a per-dose basis. Research to date indicates that this is due to a combination of the high intensity of the SD light pulses, which can produce thermal effects, along with spectral differences in the UV output. The combination of higher inherent UV efficiency and higher inactivation rates of the SD lamp make it especially suitable for disinfecting drinking water. This has the potential to make UV disinfection practical for use with all microbes.



Phoenix Science & Technology, Inc.'s pulsed surface discharge lamp (shown above) disinfects drinking water using a pulsed electric discharge that generates a light-emitting plasma along the surface of a substrate.

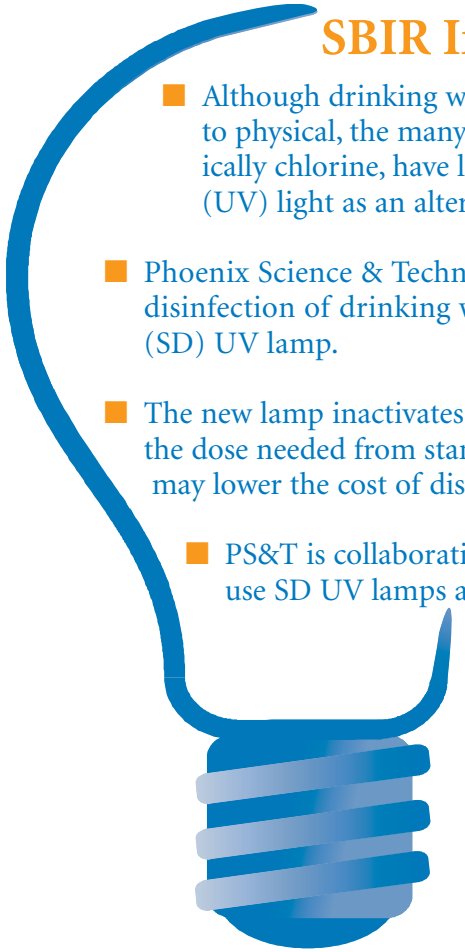
Commercialization Information

PS&T is collaborating with major water treatment companies to use SD UV lamps as replacements for commercial mercury lamps. Trojan Technologies, Inc., has provided mercury lamps for use in comparative testing and is working with PS&T to implement a cost-effective SD lamp system into their product line. The current SD lamp has been designed to allow direct replacement in existing water treatment systems. The next steps are to develop a reactor optimized for the SD lamp's UV spectrum and high intensity, demonstrate disinfection of drinking water, and develop a commercial prototype.

Company History

Phoenix Science & Technology, Inc., was founded in 1994 and is located in Chelmsford, Massachusetts. The company carries out research and develops innovative pulsed light and sound sources, as well as related pulse power components. PS&T works with leading researchers in application areas to develop a quantitative scientific basis for the performance of its technologies. PS&T licenses its technology, collaborating with manufacturers and end users to commercialize its technologies.

PS&T employs 12 people and has a fully equipped laboratory where it has developed underwater acoustic sources, the SD lamp in an Advance Technology Program sponsored by the National Institute of Standards and Technology, and used the lamp for paint stripping and water treatment in programs sponsored by EPA, the U.S. Department of Housing and Urban Development, and the National Science Foundation.



SBIR Impact

- Although drinking water disinfection methods range from chemical to physical, the many disadvantages of chemical disinfectants, specifically chlorine, have led to increased interest in the use of ultraviolet (UV) light as an alternative.
- Phoenix Science & Technology, Inc. (PS&T), demonstrated improved disinfection of drinking water with its new pulsed surface discharge (SD) UV lamp.
- The new lamp inactivates standard microbes with one-half to two-thirds the dose needed from standard UV mercury lamps, is mercury free, and may lower the cost of disinfecting drinking water.
- PS&T is collaborating with major water treatment companies to use SD UV lamps as a replacement for commercial mercury lamps.