UV technology nears commercialization

FOR INVENTORS OF ENVIRONMENTAL technologies, the race to commercialization often resembles a grueling marathon - - just ask physicist Alex Wekhof. After more than four years, Wekhof is nearing the finish line with an ultraviolet (UV) light technology that destroys organic contaminants in water, air and soil.

Wekhof entered the home stretch in February, when the U.S. Patent Office informed him of its intent to issue a patent covering his UV destruction process. Two months later, the office notified him of its intent to issue equipment patents covering the system's reaction chamber and novel flashlamp design.

For Wekhof, the race began in 1988, when he founded Ultraviolet Energy Generators Inc. (UVERG; Oakland, Calif.) "to develop new ultraviolet light methods for pollution control and toxic waste disposal." His training, however, began in the early 1970s at Moscow's Lebedev Physics Institute, where he performed doctorate-level research on high-powered, pulsed UV sources as part of an international program on photochemical lasers. He immigrated to the United States in 1979 and continued his work on mass and radiation transfer at the University of California's Lawrence Berkeley Laboratory. He later worked for several high-tech companies before deciding to strike out on his own in 1986. "I saw many opportunities to use my skills for developing useful ultraviolet machines," he recalls, "but universities and corporate structures did not have resources for my ideas, so I turned first to consulting and then to private investors."

Despite Wekhof's credentials and experience, UVERG began running short of money in the fall of 1989, forcing his contractors to look elsewhere for income. Wekhof's concerted fund-raising efforts eventually attracted the attention of Don Dresselhuys, who in 1990 became active in directing the company's development. Besides business experience, Dresselhuys brought much needed cash in the form of a strategic investor. This infusion of cash allowed Wekhof to continue development and perform more process tests for potential customers.

Wekhof s efforts eventually culminated in a third-generation UV destruction system that combines conventional advanced oxidation processes (AOP) and a phenomenon known as direct photolysis, where UV light dissociates, or decomposes, organics directly.

UV refers to a range of radiation wavelengths shorter than those in the visible spectrum and longer than those in the X-ray region. The UV spectrum stretches from about 400 nanometers in the violet end of the visible spectrum to about 180 nanometers. (One nanometer equals one-billionth of a meter.)

First-generation UV technologies typically rely on AOP, where energy from conventional mercury vapor lamps emitting a particular UV wavelength — usually 254 nanometers — is used to generate active radicals from such additives as hydrogen peroxide or ozone. The radicals, in turn, destroy organic contaminants.

UV also can destroy organic compounds directly by breaking their chemical bonds in a process known as photodissociation. For dissociation to occur, the UV wavelength must match the absorption band of the target compound, a condition Wekhof says is not easy to achieve with conventional medium- and high-pressure mercury lamps. In second-generation technologies, he continues, such substances as iodide or magnesium are added to the lamps to enhance their ability to dissociate organics directly. However, even these substances have limited effects, he adds.

Physicist Alex Wekhof's UV destruction process relies on a phenomenon known as direct photolysis, where UV light dissociates, or decomposes, organics.

Unlike first- and second-generation technologies, the Wekhof process relies on a pulsed source that produces wavelengths covering the entire UV spectrum under 320 nanometers. According to Wekhof, the UVERG flashlamp emits "twice as much UV light below 300 nanometers as a conventional xenon lamp operating at the same electrical parameters.

"Having a broad UV continuum and running the lamp within specific power ratios brings results which cannot be achieved with conventional lamps," he continues. "Even very stable toxic organic compounds that are difficult to remove with conventional technologies, such as TCA (trichloroethane), DCA (dichloroethane) and carbon tetrachloride" can be removed effectively with the UVERG technology. Wekhof attributes the lamp's success to the ability to vary its power ratio, which shifts the bulk of UV radiation to match more closely a contaminant's absorption band.

Also important, Wekhof says, is the system's reactor design, which takes into account a wastestream's absorption properties. "Since all treated water has its own absorption band, the reactor dimensions must be customized to allow the UV to work efficiently through the whole volume of water," he explains, noting that such adjustments are determined through tests conducted before a reactor is built.

The portable UVERG systems, which are 5 feet tall, 4 feet wide and 2 feet deep, weigh less than 900 pounds and process up to 100 gallons per minute of contaminated water. They can be used alone or in conjunction with techniques that reduce volume or transfer contaminants from water to air. "It is much easier to deal with air than water flows," Wekhof says, "because it requires less energy to move air, plus (equipment) for air is less expensive. Volume reduction allows (us) to increase a concentration of targeted organic compounds to the level where the action of the ultraviolet light is the most efficient. This can be achieved by passing air through the water several times until it is saturated with organic compounds. Contaminated water also can undergo a volume reduction by filtering it."

Besides water and air treatment, the technology can be used to remediate contaminated soils. "The first application, besides its obvious use in combination with soil ventilation," Wekhof says, "is onsite cleanup of soils (contaminated by) spills of PCBs, PNAs (polynuclear aromatics), such as naphthalene, and other toxic organic compounds that are difficult to remove with traditional methods."

At press time, UVERG had one 8-kilowatt demonstration unit and was in the process of building its first commercial system, which was scheduled to be installed this month. Both systems contain interchangeable reactors that allow them to handle water or air. (The processing reactor for air treatment is larger and air-cooled.) Such units cost about $65,000, plus $10,000 for installation. According to Wekhof, operating costs will run between $1 and $3 per thousand gallons, depending on the wastestream.

Wekhof says UVERG initially will target specific, but as yet unidentified, niches within the groundwater and industrial wastewater treatment markets. "Our goal over the next year," he relates, "is to identify niches in both the air and water markets where our technology is the most cost-competitive treatment option."

To pursue its commercialization goals, UVERG will rely on remediation contractors serving the groundwater and industrial wastewater treatment markets. The company is pursuing similar relationships in Europe and the Far East, Wekhof says, and plans to establish a core technical service and training team to support its distributors, represent it at conferences and trade shows, and pursue media attention.

UVERG also plans to establish a "small R&D operation to continue development of products to more fully meet the needs of the marketplace," he continues. "Beyond the current product design, (we) see the need for additional products to extend the technology to soil and air pollution, as well as continuing to improve water treatment applications."

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