GETTING CLEAN AND GREEN WITH UVC TECHNOLOGY

Using ultraviolet light in HVAC systems to eliminate harmful airborne compounds continues to grow in popularity—and credibility—in today's marketplace.

BY ROBERT SCHEIR, PH.D.

The March 2008 *RSES Journal* article "Putting UVC Under a New Light" focused on the growing acceptance of ultraviolet C devices designed specifically for installation in HVAC systems (the C wavelength of the UV spectrum targets microorganisms' DNA, destroying their cells or making replication impossible). Two years later, this trend of acceptance continues as growing numbers of contractors, engineers, building owners and professional organizations recognize the multiple benefits of germicidal UVC technology.

One example is the Rio Grande Regional Hospital in McAllen, TX, which has reported dramatic energy savings since adopting UVC lights. In a 6-month test period from January–May 2009, electrical costs dropped 29.5% over the same period in the previous year, despite a hike in utility rates. The hospital estimates an annual savings of $500K/year since the initial test.

And after outfitting more than 100 air-handling units in seven of its campuses in the Orlando, FL-area with UVC, Florida Hospital found the UVC devices to be an excellent alternative to coil cleaning. Florida Hospital has successfully eliminated more than 200 coil-cleaning procedures annually, saving $500–$6,000 per cleaning. The USGBC also has approved UVC for energy conservation.

Update on acceptance

One important form of acceptance accorded to UVC has come from ASHRAE. The updated "2008 ASHRAE Handbook—HVAC Systems and Equipment," contains a new technical chapter titled "Ultraviolet Lamp Systems"—ASHRAE's first formal inclusion of UVC in its recommended practices. It includes a review of the fundamentals of UVC germicidal energy's impact on microorganisms; how UVC lamps generate germicidal radiant energy; common approaches to the application of ultraviolet germicidal irradiation systems for upper-air room, in-duct, and surface cleansing; and a review of human safety and maintenance issues.

Another recent UVC publication is the "ASHRAE Airborne Infectious Diseases Position Document," published in June

‹‹ Heat-pump units serving the patient rooms at the Muskogee Community Hospital in Muskogee, OK, are outfitted with UVC emitters (circled) for infection control, and energy and maintenance savings.

2009. The report finds that airborne transmission of diseases such as H1N1 through heating and air-conditioning systems is much more common than previously thought. In the document, ASHRAE recognizes UVC's beneficial role in preventing airborne transmission of diseases, citing it as one of the recommended control strategies. Other measures include dilution ventilation, air-flow strategies, room pressurization, personalized ventilation, source control and air filtration. *[Editor's Note: The full report on airborne infectious diseases can be read online at www.ashrae.org/positiondocuments.]*

ASHRAE is developing a UVC test standard, but it will be some time before a final standard is released. In lieu of this, the best available resource is a series of test reports commissioned in 2006 by the EPA, in conjunction with the National Homeland Security Research Center through its Technology Testing and Evaluation Program. The reports, which provide detailed information on nine leading UVC devices, offer a useful benchmark for comparing performance of various UVC devices. The reports can be accessed at www.epa.gov/NHSRC/news/news100406a.html.

UVC's benefits

In addition to ASHRAE acceptance, and as noted in earlier examples, UVC's growing popularity has been fueled by the trend toward green/sustainable building practices. This offers diverse operational advantages, as follows:

→IAQ and infection control—UVC improves air quality by preventing the spread of infectious diseases, and also by reducing the allergy and asthma symptoms commonly triggered by biofilm, a matrix of bacteria, mold, debris and other organisms that are widely prevalent in air handlers. Additionally, UVC creates safer, more comfortable indoor environments and has been linked to improved productivity in office buildings, reduced absenteeism in schools, and reduced likelihood of occupant complaints or litigation.

A 7 ½-year study conducted in the in vitro fertilization cleanroom laboratory of the Lehigh Valley Hospital and Health Network found that the use of UVC lights installed in the HVAC system had a clinically significant impact on clinical pregnancy rates. Authors found that UVC played a critical role in the improved clinical outcomes by destroying airborne microbial contaminants and degrading harmful VOCs. Another study by McGill University scientists found that UVC devices reduced overall sickness by 20% and respiratory symptoms by 40% in Montreal office buildings, with a substantial effect in reducing reported work-related illnesses.

→Energy savings—Studies and field experience show that even a thin layer of buildup on a coil substantially increases energy consumption. By continuously cleaning coils, UVC eliminates biofilm much more effectively than conventional cleaning methods—saving energy by maintaining equipment at factory design efficiency. [*Editor's Note: ASHRAE published a study in 2006 in* ASHRAE Journal *(Vol. 48), "Study Verifies Coil Cleaning Saves Energy," detailing the energy-saving benefits of UVC.*]

→Maintenance savings—Manual coil cleaning is a major HVAC maintenance expense and can be very difficult to perform on small, tough-to-access packaged systems. UVC solves these problems by greatly reducing or even eliminating the need for chemical cleaning or pressure washing of any size coil. It also eliminates the associated equipment downtime, inconvenience, and potential discomfort of occupants, as well as worker exposure to cleaning chemicals.

›› Comparison photos of a typical fan coil at Number One York Quay, a luxury condominium complex in Toronto, Canada. The inset photo shows the fan coil before a UVC germicidal light was installed; the main photo shows the coil's cleanliness after installation.

→**Equipment service life**—The surface-cleaning effect of UVC helps restore even older HVAC systems to efficient operation, making it possible to prolong the life of aging air handlers.

→**Water conservation**—Reclaiming UVC-cleaned condensate for cooling tower makeup, irrigation, or gray water flushing can reduce water and waste-water costs.

→**LEED contribution**—Because of these varied benefits, UVC may contribute to earning LEED points in one or more areas.

Areas of application

UVC is effective against all known forms of organic microbes. Microbial contamination comes from a variety of sources. It may originate in HVAC systems due to the presence of biofilm on coil and drain-pan surfaces. It may be introduced by an infected occupant and recirculated through the building by the air-handling system. It may originate from an act of bioterrorism or by outside bacterial contamination—as occurs with Legionnaires' Disease.

To make the most of UVC, it is important to understand the two primary areas of application for the devices in HVAC systems:

→**Surface decontamination of cooling coils and drain pans**—In this application, UVC removes and prevents further growth of biofilm, which leads to a range of IAQ and operational problems that are sometimes mistakenly attributed solely to mold. The effectiveness of UVC for surface decontamination in HVAC systems was first documented in a research study titled, "Effectiveness of Germicidal UV Irradiation for Reducing Fungal Contamination within Air-Handling Units," published in the August 2001 issue of *Applied and Environmental Microbiology*. The study, conducted in a 286,000-sq-ft office building, found UVC light fixtures effective in reducing more than 99% of fungal contamination within air-handling units.

→**Airborne control of recirculating viruses, bacteria, mold spores and VOCs**—The application of UVC to control airborne contaminants can be further broken out into two categories: general air cleaning/IAQ control; and hospital-/medical-infection control. The first category includes a wide range of applications in commercial buildings, where there are typically 4–6 air changes per hour—a sufficient rate for UVC devices in the air handlers to reduce contaminant levels below what affects most people. The second category typically refers to hospital and medical environments, and also may encompass manufacturing cleanrooms. In these applications, UVC will successfully deliver contaminant destruction rates above 99%, when properly applied in combination with high air-exchange rates of typically 15–20 air changes per hour or more.

Though some in the industry contend that treatment of the coil versus treatment of the airstream are separate issues and that UVC should be applied differently for each, it is this author's position that the preferred location of the device for *both* types of applications is at the coil, ideally with the devices installed on the supply side of the system, downstream from the cooling coil and above the drain pan. Why?

UVC at the coil location provides more effective control than in-duct UVC installations, because it attacks contaminants *at the source* to deliver simultaneous cleaning of surface and airborne microbes. The United States General Services Administration has for several years included this recommendation in its standard for federal facilities, which calls for UVC lights to be incorporated "downstream of cooling coils and above drain pans to control airborne and surface microbial growth and transfer."

Sizing and lamp position tips

When sizing UVC devices for HVAC systems, there are three basic application scenarios from which to choose:

→General IAQ control with a used coil already growing a biofilm;

→General IAQ control with a new coil that has not been used and has no biofilm/mold; and

→General IAQ and/or infection control in hospital and medical facilities.

Device manufacturers will state the recommended number of devices for an application. An existing fouled coil will require more coverage than a brand new coil; and for hospital-/medical-infection control applications, coverage requirements will be greater still.

On medium to large commercial coils, the best location for the devices is horizontally across the full width of the face of the coil, on the supply side of the system, downstream from the cooling coil and above the drain pan, as previously noted. If downstream positioning is not feasible, UVC devices may be installed upstream of the coil. For control of hospital-acquired infections or other infection-control applications, the customer will typically name the specific contaminants to be targeted and specify the required destruction rates.

For smaller systems, such as unitary or packaged air-handling systems—including fan coils, PTAC units, heat pumps, etc.—space limitations or access problems may preclude horizontal installation. In such cases, it is sometimes necessary to install lamps through the housing. This is referred to as vertical installation. Again, more lamps will be necessary to provide the desired germicidal coverage when compared to horizontal installations.

It also is important to note that proper sizing is highly dependent on the output or UVC energy emitted by the selected UVC device. These devices fall into two basic groups: new-generation high-output lamps introduced in the '90s and engineered specifically for HVAC use; and older-style UVC lamps that produce considerably less output.

The output of various devices can vary drastically, evident by comparing performance results published in EPA test reports. Simply stated, the lower the output, the more coverage you will need to achieve microbial destruction—which can translate into a larger number of lamps, more complex installation requirements, and heavier use of electrical power. Recommended output is 9 µW/linear in. of glass measured from a distance of 1 m, tested at an air velocity of 500 fpm at 50°F.

[Editor's Note: Readers can see an expanded version of this article with information on UVC-lamp operation and changeout at www.rsesjournal.com.]

Service contractors and technicians have a wide range of versatile UVC technologies available to meet urgent needs for green and sustainable products that save energy, enhance IAQ and infection control, reduce HVAC coil maintenance, and much more. Understanding how to incorporate these products into today's HVAC systems—and reduce airborne pathogens and other VOCs—can generate increased profits for the contractor, and improved health and productivity for the customer.

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