Shining LIGHT On UVC Output

UVC can work wonders for an hvac system, but if output is inadequate the lights will not perform their desired function or will need frequent replacement

BY ROBERT SCHEIR

Ten years ago, the installation of ultraviolet-C (UVC) lights in air-handling systems was an experimental and developmental practice. Today, the devices have come a long way in terms of market penetration and user acceptance.

The ability of UVC devices to control mold and IAQ has been well documented in both commercial and residential settings. But the benefits extend far beyond IAQ enhancement. UVC lights keep coils, drain pans and other components clean and free of organic buildup, eliminating the time, cost and potential hazards associated with chemical cleaning programs.

By keeping coils clean, UVC lights also increase system efficiency, reducing energy and operating costs. Hvac energy savings of 15 to 20 percent or more are not uncommon. As a result, a UVC installation can often pay for itself in a matter of months.

As with any emerging technology, however, misinformation sometimes exists. With UVC, the most common misconceptions center on the critical issue of "output" or intensity. Why is this so important? Because if output is inadequate the UVC lights will not perform their desired function and/or will need frequent replacement.

When we hear a customer say, "I tried UVC lights in my building and they didn't work," inadequate output is most often the culprit – whether it is caused by incorrect lamp selection, improper sizing or inappropriate location within the a/c system.

Many professionals don't fully understand output issues and assume that all installations are pretty much the same. This article will provide a general explanation of how UVC output works, how it is tested, and considerations that play into purchasing, installation and servicing decisions.

How UVC works

UVC is a type of ultraviolet (UV) energy in the 254-nanometer wavelength. The C wavelength is the most germicidal in the UV spectrum. This wavelength targets the DNA of microorganisms, causing cell death or making replication impossible. The UVC energy kills or inactivates microbes, eradicating surface and airborne mold, as well as viruses and bacteria. Output of UV devices is measured in microwatts (µW) per square centimeter.

UVC light has been used for decades to kill harmful microorganisms in many applications, particularly for disinfection of drinking water and for upper-air infectious-disease applications in room-temperature environments. The older-style, conventional UVC lights used in these applications, however, suffer drastic output losses when exposed to cold or moving air. As a result, in past decades the hvac industry did not adopt UVC technology.

The situation changed in the mid-1990s with the advent of a new generation of devices that were specifically engineered to provide peak output for hvac systems. The new-generation UVC lights are verified through independent testing to provide output per inch of glass of at least 10 µW/cm² at 1 meter in a 400 fpm airstream of 45° F. (In the following section, I will explain what this means in greater detail.)

Output of the newer devices was so much greater than conventional tubes in cold and moving air that they could be installed just downstream of a cooling coil, which also encompasses the drain pan and other damp locations of an air-handling system. The high output UVC energy would not only "zap" both coil and drain pan mold and bacteria (to eliminate their toxins, VOCs, spore production and allergens), it would also remove ordinary organic coil and drain pan debris.

Comparing output of UVC lights

Today, UVC devices marketed for hvac applications fall into two basic categories: those with the new generation "high-output" lamps and those with the older-style lamps. Both types lose output on a linear basis over time, generally reaching their half-life after about one year or 9,000 operating hours. Since output decreases over time, it is important to have an accurate understanding of a device's initial output.

This is where the going gets tricky. When selecting air filters, you can compare products by noting the minimum efficiency reporting value (MERV) designation of 1 to 16, dust-holding capacity or other accepted standards of measurement. But UVC for hvac is a much newer technology, and there is not yet an accepted performance standard within the industry by which to compare different devices.

ASHRAE is forming a standards committee to address the issue, but it will probably take several years to develop and approve a UVC standard. Until that happens, the buyer or specifier must shoulder more responsibility and be willing to sift through the various product claims to make an informed purchasing decision. Here are some questions to ask potential suppliers about output claims:

• Has output testing been performed by a certified test laboratory? Although there is not yet an ASHRAE standard for UVC, there are certified test facilities that will perform independent output testing under defined test conditions.

• Are output claims based on hvac operating temperatures? Older-style lamps are often tested in still air at 90° F, rather than under hvac operating temperatures. Warm/still air

The ABCs of UVC terminology

You need to know that manufacturers of UVC devices do not always use the same terminology, leading to potential confusion. Here are some common terms you might see and what they mean:

➤ UV: If a product is described simply as a UV light, it may or may not produce output in the germicidal C wavelength. If you don't see the C, ask the supplier for further clarification.

➤ UVGI: This stands for ultraviolet germicidal irradiation (UVGI), a term used by federal agencies such as the Occupational Safety and Health Administration (OSHA), the National Institute for Occupational Safety and Health (NIOSH) and the Centers for Disease Control (CDC) when referring to UVC. It is synonymous with UVC.

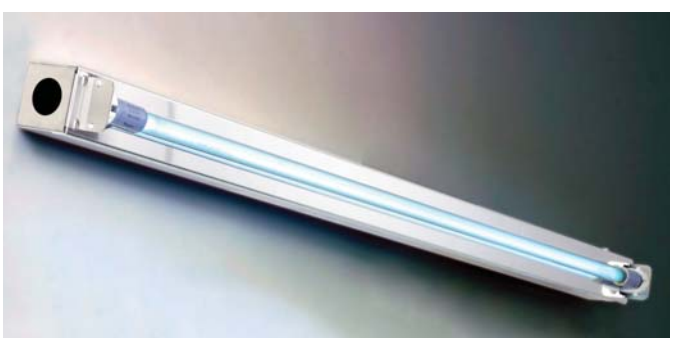
➤ UVV: This refers to a shorter (185 nanometers) wavelength on the UV spectrum. Some products on the market actually produce UVV light in addition to UVC, and the marketers of these products tout UVV as an additional tool for IAQ control.

There is one significant drawback to such products. The shorter wavelength of UVV light actually generates ozone. This occurs because UVV light reacts with oxygen to break it into atomic oxygen, a highly unstable atom that combines with oxygen to form O_3 (ozone).

The American Lung Association states that "exposure to ozone causes a variety of adverse health effects, even at levels below the current standard." And the U.S. Food and Drug Administration says: "In order for ozone to be effective as a germicide, it must be present in a concentration far greater than that which can be safely tolerated by man and animals."

The longer (254 nanometers) wavelength of UVC light, by contrast, provides highly effective air, surface and water disinfection without producing any harmful ozone.

The materials and methods of UV lamp construction determine whether a given UV device will produce both UVC and UVV light or only the safer UVC wavelength. — *Robert Scheir*



Top: An A/C coil treated with high-output UVC lights.
Middle: Single-ended fixture style used in a variety of commercial and residential applications.
Bottom: Double-ended fixture style used in large commercial applications.

conditions are very different and will yield more favorable output results for such lamps. Be wary of any output claims that are not based on hvac-type conditions (for example, 400 fpm airstream at 45° F).

• Are output claims based on tests performed at a distance of 1 meter? Standard UV output testing is performed with a sensor placed one meter from the light source. Intensity falls off exponentially as distance increases (see Figure 1), so some manufacturers test their lights from shorter distances — sometimes as little as 6 to 12 inches — to yield higher output readings.

• Are output claims stated per inch of glass? Longer UVC lamps yield a higher measured output when compared to a shorter lamp of the same construction.

Thus, to get a direct comparison between different devices, total output of the lamp must be divided by the number of inches of glass. One inch of glass is the common denominator to look for.

In summary, when reviewing output claims, make sure the supplier has stated all the test conditions – temperature, air velocity, distance from the measuring sensor and source of the test data. As noted earlier, a true high-output UVC device will provide output per inch of glass of at least 10 µW/cm² at 1 meter in a 400 fpm airstream of 45° F.

Figure 2 compares the output of a new generation UVC light with that of standard older-style devices across a range of temperatures. Figure 3 compares the two styles of lights at hvac temperatures.

How output affects service life, performance

I've reviewed how output should be tested and measured, but what impact does this have on real-world performance? As noted earlier, UVC lights lose up to half their output over a year.

When older-style lights are used in an hvac installation, they may seem to be effective at first. After a few months, however, the odors and allergic reactions associated with mold growth begin to return. Such devices must generally be changed every three to four months because they quickly lose the output needed to maintain microbial control.

A high-output UVC device, by contrast, typically has a 12-month service life. Even after a year, this device may still have two to three times greater output than older-style lights can provide on the first day of service. This extra output provides the needed germicidal performance over a longer period of time and ensures that there will be no return of microbial growth.

How do you know when it's time to change the lights? One way is to measure output loss with a radiometer. A good radiometric device can measure UV output in both µW/cm² and also on a percentage basis that is predefined by the user — you can set the device to let you know when output has declined by a given percentage, signaling the need to change out the lamps.

Radiometers are strongly recommended for large or critical applications. In a multilamp installation, however, the sensor only will read output of one lamp as a function of the entire installation. So the use of radiometry, while quite reliable, is not foolproof.

When a radiometer is impractical, changeouts based on time are recommended. With high-output lights, annual replacement is the rule of thumb. However, lights with lower output will generally require more frequent replacement to maintain IAQ control for the reasons noted above. Follow the manufacturer's recommendations when in doubt.

Other indicators that output has fallen below acceptable levels include the return of mold growth, odors or allergic symptoms among building occupants. If this occurs before the scheduled changeout, inspect the system to find the source of the problem.

The culprit may be premature failure of one or more lamps, an electrical problem in the system, or simply that the lights are being cycled on and off instead of running continuously. A periodic visual check is also a useful way to make sure the lights are operating, although inspection alone should not be used to make changeout decisions.

Maximizing UVC effectiveness

When you are using UVC to clean an a/c coil, the light penetrates the coil through reflection. As it kills and cleans the

mold immediately exposed to the lamp, this wavelength of energy begins to reflect off the fins of the coil and bounce through, gradually cleaning more of the coil. On a multi-row coil, if heavily fouled, it may take a month to work all the way through.

To best achieve coil cleanliness, position the lights perpendicular to the fins of the coil, spacing them to deliver equal output across the face of the coil. When using high output lights to clean a fouled system, a 24-inch centerline is recommended. The rule of thumb for new construction is a 30-inch centerline.

If using a lower output device, you will need a multiplicity of lights equal to the reduced output. This may involve installing two to five times as many lamps across the length of the coil.

The above sizing parameters are intended primarily for IAQ control and coil cleaning. In such applications, the lights will reduce the level of airborne microorganisms in the occupied space significantly, ranging from 50 to 90 percent "per pass" kill rates, depending on the organism. Benefits are especially pronounced in schools, where absentee rates from colds and viral infections can be reduced.

For infectious disease applications (healthcare facilities) and for control of specific organisms such as tuberculosis, kill rates of 99 percent are often targeted. In such cases, the centerline will need to be reduced and calculations must be made case by case.

Reflective surfaces can boost the effectiveness of UVC lights by adding to the "killing field." Aluminum surfaces, for example, provide 85 percent reflection. Walls can be lined with reflective materials or coatings for this purpose, and some UVC devices come equipped with metallic reflectors. Such measures can be helpful but will not overcome a lack of initial output.

It should be clear by now that UVC lights can vary greatly in terms of output and performance. A lower-cost device may not be the wisest choice, if it necessitates the use of more lights in the system and accelerated change-out schedules to attain the desired germicidal effect.

By knowing how to evaluate and compare UVC devices, you can help your customers save money, improve performance and enjoy all the benefits UVC has to offer – on a consistent and reliable basis.◆

Robert Scheir is president and ceo of Steril-Aire Inc., a leading manufacturer of UVC devices for commercial and residential applications. For more information, write Steril-Aire Inc., 2840 N. Lima St., Burbank, CA 91504; call 800-278-3745 or 818-565-1128; fax 818-565-1129; e-mail sales@steril-aire.com; or visit www.steril-aire.com

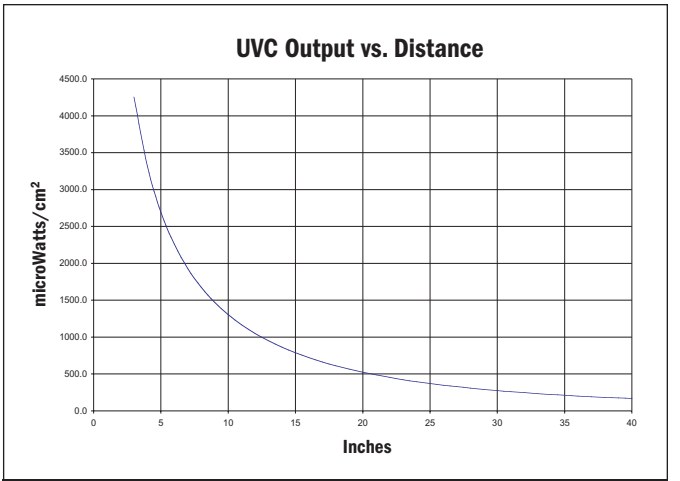


Figure 1. Intensity falls off exponentially as distance increases, so some manufacturers test their lights from shorter distances.

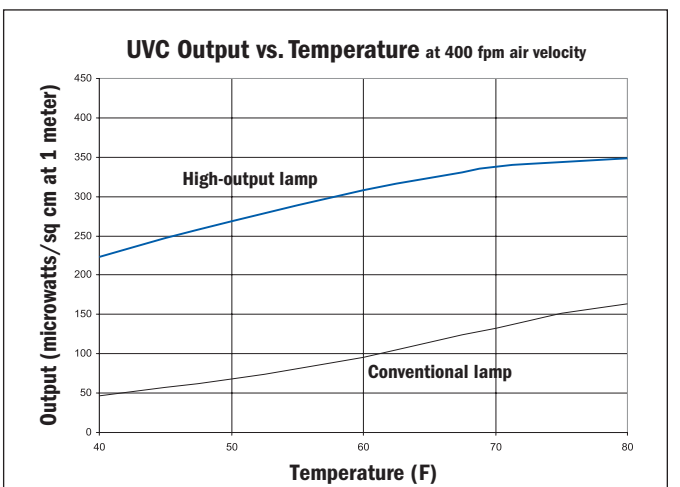


Figure 2. The graph compares the output of a new generation UVC light with that of standard older-style devices across a range of temperatures.

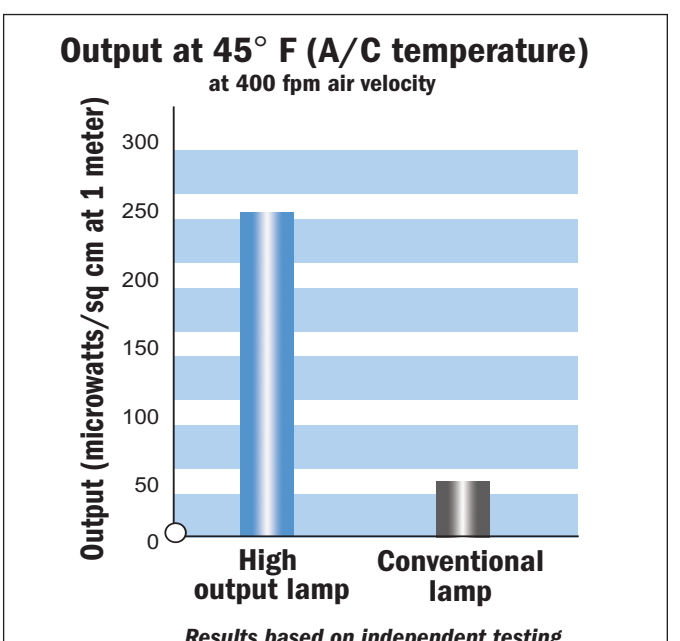


Figure 3. The graph compares the two styles of lights at hvac temperatures.