

UV Light: A Tool for IAQ Solutions

Applied correctly, ultraviolet light systems can kill bacteria and other air-borne contaminants, thereby improving the air quality inside homes and businesses alike

BY GREGG BURNETT

The increase in public awareness of mold and other airborne contaminants has increased the importance of providing consumers with effective solutions to their indoor comfort needs. Laboratory results clearly demonstrate that ultraviolet (UV) light systems offer useful and efficient methods of fighting unhealthy air in a home.

Generally easy to install and maintain, most UV light systems operate seamlessly with both existing or newly installed hvac systems. Recent advancements in UV light technology have led to the introduction of increasingly powerful, safer and easier-to-install units than previous models.

By increasing the microbial killing capability against surface and airstream contaminants such as molds, bacteria and viruses, and promoting better coil efficiency, a healthier indoor environment can be created.

What is UV light?

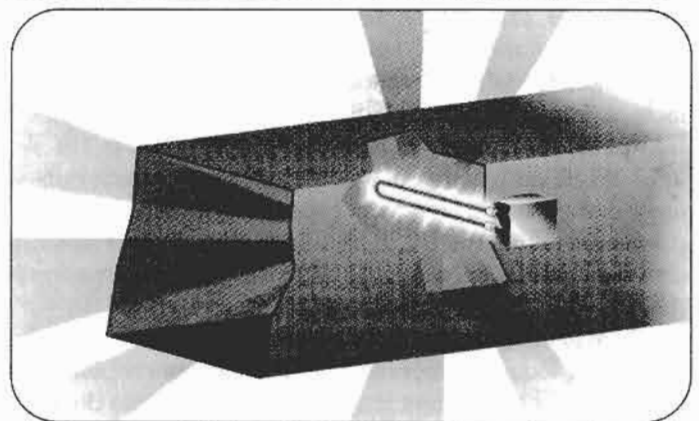
Ultraviolet represents the frequency of light between 200 nanometers (nm) and 400 nm, and cannot be seen with the naked eye. Within this spectrum lie three distinct bands of light: UV-A, UV-B and UV-C. Longwave UV light (315 nm to 400 nm), or UV-A, refers to what we commonly call black light. UV-B (280 nm to 315 nm), or midrange UV, causes sunburn.

Germicidal UV light (200 nm to 280 nm), or UV-C, is effective in microbial control. Research has demonstrated that within this UV-C band the most efficient frequency for microbial destruction is between 254 nm and 265 nm. Germicidal lamps that produce the majority of their output in this range will be the most effective in microbial control/destruction.

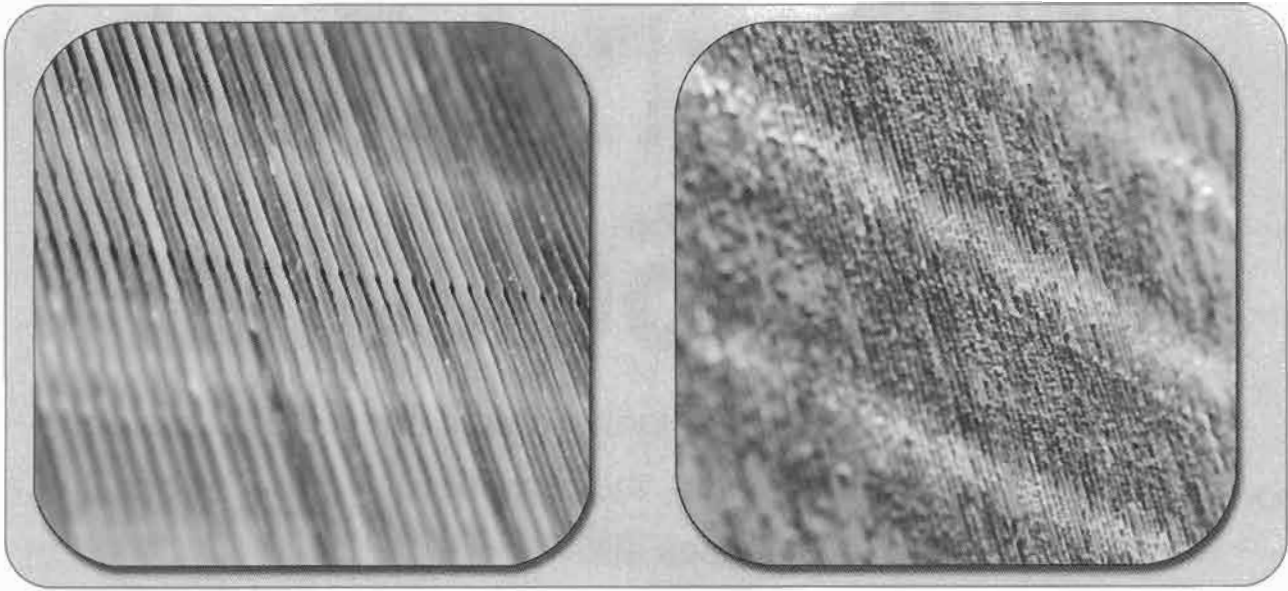
The germicidal benefits of UV lights were first used in the area of water purification in 1909. Not until 1930 did industry begin to apply this technology to air purification, primarily in hospital and school environments as these early UV light systems were far too large and expensive for general residential use. Today, technological advances and improved production processes allow UV light to be an affordable air-quality solution for the home and office.

How UV systems work

UV-C light possesses the unique ability to penetrate the thin cellular wall of a microbe and damage its DNA. Particularly lethal to smaller microbes, actually killing them outright, UV-C renders larger microbes harmless, sterile or unable to spread. Two factors – time and microbial resistance to UV energy – determine how effective UV-C light will be against a specific pathogen. This becomes critically important when looking at surface vs.



The proper bulb length results in a thorough application of UV-C light.



UV light is effective at killing both airborne and surface-based bacteria, such as on a pleated air filter (above).

airstream microorganism control.

Recent laboratory tests of surface UV-C application technology clearly demonstrate its effectiveness on both coils and filter media. One such test's protocol was designed to replicate the deployment of a UV-C light array upstream, or prior to, a bank of pleated filters that had been inoculated with captured *Bacillus thuringiensis* (Bt) spores. Bt was chosen as the surrogate challenge since the DNA of Bt is virtually the same as the DNA of *Bacillus anthracis*, commonly referred to as anthrax. Application of the UV-C light from the 16-inch high-output lamp at a distance of 12 inches for 15 minutes resulted in a 74 percent spore count reduction as compared to the control sample.

Eradication of airstream microbes requires a considerably higher amount of UV-C output by the unit than when attempting surface microbial destruction. Other variables that must be addressed to increase UV-C output involve temperature, air velocity, the decay rate constant of the pathogen and the condition of the lamps.

The first variable, air velocity, relates to one of the two factors previously mentioned – time. Higher-velocity airflow equates to less time the microbe is exposed to UV light. While destruction of smaller microbes occurs during a first pass, the larger microbes may require several passes. Installing the UV light unit in a location of slowest air speed greatly enhances its effectiveness by increasing the exposure time of microbe to UV-C.

Ultraviolet light energy decreases with distance, which affects the second component in airstream microbial control. Utilizing the correct length of bulb in a given duct results in a more thorough UV-C application across the airstream. The appropriately sized lamp should be long

enough to come within 1 to 3 inches of the opposite side of the duct.

Lastly, the temperature within the kill zone demands consideration. High output lamps, combined with the latest technology in ballast design, ensures that an installed UV-C unit will give the best performance possible at lower temperatures. Some UV manufacturers have published data that indicates microwatt output at specific temperatures in conjunction with air velocity.

Installation and maintenance

Optimal microbial control and efficiency are achieved by installing the UV-C light unit in the best location in a given system, and selecting the most appropriate unit for

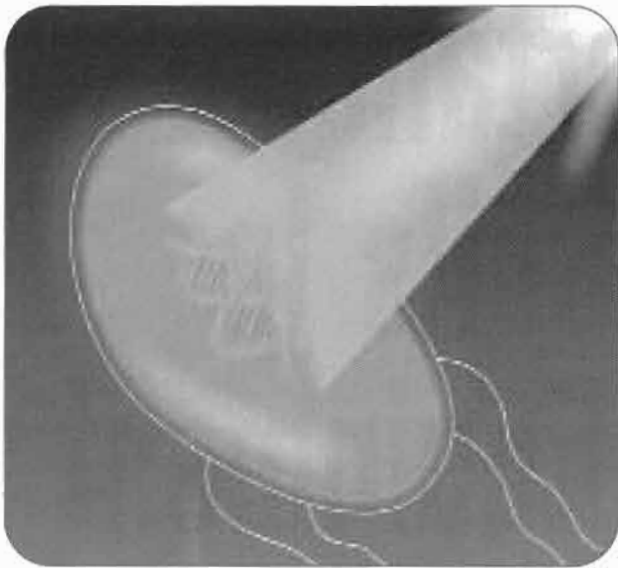
the application desired. In order to achieve the maximum amount of eradication of both surface and airborne microorganisms, place the unit above the coil.

In a heat-only application, or where space prohibits installation downstream of the coil, the UV light should be installed in front of the air filter. Check with the filter manufacturer on whether filter degradation will occur if it is exposed to long-term, high intensity UV-C light.

Other installation locations to consider involve the proximity of the light to UV-sensitive materials such as plastic and rubber. Such components are not always resistant to UV-C and may deteriorate over time by becoming cracked or brittle. If cause for concern exists, shield the component(s) with aluminum foil tape.

To eliminate the risk of over-exposure to UV-C, do not place the unit in a closet return grill. Always follow practical electrical guidelines to avoid the possibility of an electrical fault by avoiding the placement of an indoor unit in an outdoor area or beneath any source of water.

Maintenance of a UV-C light system should include annual replacement of the bulb(s)



UV-C light penetrates the thin cellular wall of a microbe and damages its DNA, sometimes killing it outright. Airflow velocity must remain low enough to allow ample time for the light to have an effect.

Maintenance of a UV-C light system should include annual replacement of the bulb(s). Remember, UV bulbs still may be brightly lit and appear fully functional after a year's time, but the actual UV-C energy output will have diminished to the point of being less effective, particularly in the area of airborne application.

Location of a unit in a particularly dusty environment will necessitate wiping down the bulbs with a clean cotton cloth every six months to ensure maximum UV output. Dirt and/or debris on bulbs can shield microbes from exposure to UV-C light. Another aid in keeping the bulb(s) clean and the coils free of residue would be the installation of a high-efficiency air filter.

An eye toward safety

Eye safety remains a critical point when working with UV light fixtures. No one would recommend looking directly at the sun unless the eyes were suitably protected. The same can be said when working with UV-C.

Some simple precautions will go far to ensure that neither the consumer, nor the technician's eyes, become irritated or burned:

Eliminate unnecessary exposure to an activated unit (for example, do not place the unit in a closet air return). If it becomes necessary to work with, or around, the activated UV-C light fixture (a rare occurrence) always wear appropriate eye protection.

Eliminating the possibility of exposure becomes easier by practicing the following guidelines:

- Place unit in the system where accidental exposure will not occur (don't locate the unit in a closet air return).
- Never turn the UV-C system on prior to installation.
- Attach any warning labels enclosed with the UV-C light unit in a highly visible place on the ductwork. This will

inform the next person servicing the hvac system that a UV-C light fixture has been installed and must be turned off prior to servicing.

- Check for UV-C light leaks at installation or whenever general maintenance is performed. To accomplish this, turn off all external lights after unit installation/activation, check for any light escaping from the ductwork and then seal any leaks that are noted.
- Turn off the UV-C system when performing hvac system maintenance.
- Educate consumers and technicians to the dangers of unprotected UV-C exposure.

Some UV-C light systems offer further safeguards, such as a power disconnect that ensures that the light unit immediately deactivates should the cover be removed, as well as a UV-safe viewing port for verifying bulb operation.

With some homeowner insurance companies now becoming concerned about IAQ issues and the energy conservation efforts that seal the home and office environment even tighter, UV-C light is fast becoming a widely accepted technology for improving indoor air quality.♦