An Introduction to Ultraviolet Air Disinfection

By: Scott Russell

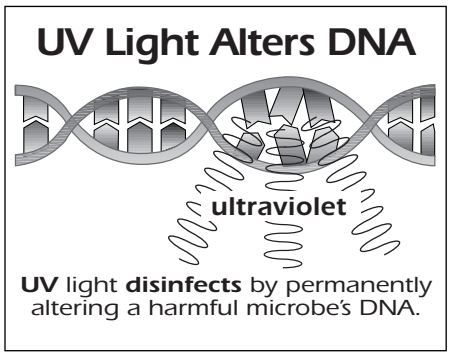
Over the years, many new technologies have been introduced to the heating, ventilation and air conditioning (HVAC) industry. One technology that is proving to stand the test of time is the reduction of airborne pathogens with the use of ultraviolet energy. In the last few years, education and awareness of ultraviolet disinfection of airborne organisms has increased dramatically. With this increase, the demand for advanced UV equipment to meet the needs of today's marketplace has risen as well. In this article, many of the commonly asked questions regarding the use of ultraviolet light in heating, ventilation and air conditioning applications are answered.

What is UV?

UV is invisible light with a frequency just below the visible spectrum. The germicidal wavelength or the frequency in the ultraviolet spectrum that best inactivates microorganisms, mold spores and viral contaminants is centered on 254 nanometers (nm). This frequency is located in the UV-C segment of the UV spectrum (see diagram below).

How does it work?

As a microbe passes through UV-C, the light penetrates to the organism's nucleus disrupting the molecular bonds of its



DNA. This disruption or breakage renders the microbe unable to reproduce. Without the ability to reproduce, the organism dies moments later leaving no offspring. Some airborne pathogens are more resilient to the effects of UV energy than others. For instance, viruses are easier to destroy than bacteria, with mold spores requiring the largest UV dose for effective reduction.

Airborne pathogens are not visible to the naked eye and many are so small that they slip right through standard air filtering devices. Adding ultraviolet air disinfection to the filtration equation prevents colonization of even the smallest microorganisms.

Typical Applications

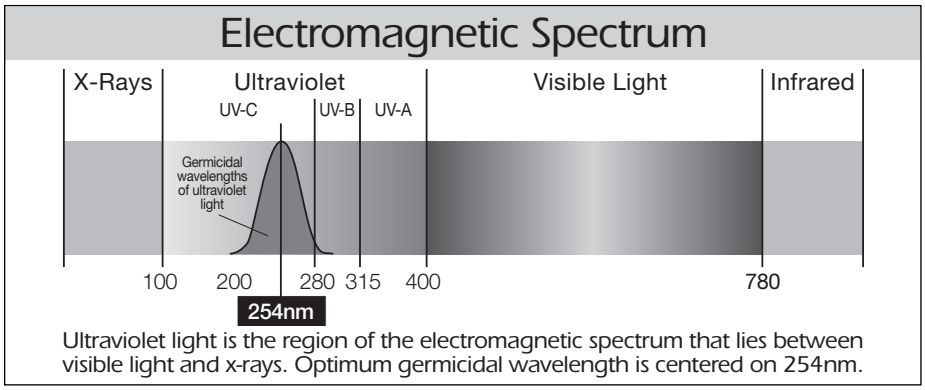
Ultraviolet treatment equipment does not replace other types of indoor air quality products. UV is very specific in its duties to destroy biological growth, hence UV systems compliment other air enhancement systems such as HEPA and electronic air cleaners. There are many practical applications for ultraviolet air treatment; a few of the more common ones are outlined below.

Throughout the country UV air disinfection systems are being installed to help curb unnecessary air quality maintenance costs. In the past, UV air disinfection systems have been most commonly used in commercial installations, but today UV air treatment is very practical and desirable for average home use as well.

The moist environment of an HVAC system can be a perfect breeding ground for airborne molds and microorganisms. HVAC systems often lose efficiency and effectiveness when bacterial and mold growth becomes excessive. A professionally installed UV system ensures a bacteria and mold free coil, because the AC coil is constantly bathed in UV energy. The prevention of biological build up results in greatly improved indoor air quality *and* a more efficient HVAC system, that measurably reduces annual energy costs.

Another common application for UV air treatment is to take control of unpleasant, persistent odors that occur in a home or office building. While UV does not act directly to reduce odors, it treats what is often the source of the problem: biological contamination in the heating or air conditioning system. Since UV light kills the organisms that have colonized there, unwanted odors are quickly reduced or eliminated.

The term "Sick Building Syndrome" (SBS) is one that refers to a hazardous condition that can occur when bacterial/viral contamination becomes excessive in HVAC equipment and/or systems.



Ultraviolet light is the region of the electromagnetic spectrum that lies between visible light and x-rays. Optimum germicidal wavelength is centered on 254nm.

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Typically people affected have symptoms that range from nausea to chronic fatigue, with the affected person(s) usually feeling better once they leave the contaminated area. A UV air disinfection system can rapidly and dramatically relieve a building from SBS and eliminate the symptoms people experience while living or working in such environments.

Another important and very beneficial application for ultraviolet air disinfection is the reduction of allergy-causing fungi and molds. Since mold is considered one of the five most common allergens, a UV system can facilitate huge improvements in symptoms of people with allergic sensitivity to mold and fungi. Many have reported a reduction of the overall occurrence of mold and mildew buildup all through the home as spores are drawn though the HVAC system, where they are directed through the gauntlet of high intensity UV. A typical UV system installation would place the UV unit about 12 inches downstream of the coil in a HVAC system (to maximize biogrowth reduction on the coil), or in the system return air duct, disinfecting the entire volume of air entering the HVAC system. Tests by independent laboratories indicate that optimum indoor air quality (IAQ) is achieved when UV is applied in return air ducts as well as near the coil.

Equipment

Today's sophisticated ultraviolet air disinfection systems provide a range of performance and safety features that have not been available in the past. Whether environmental requirements call for single or multiple lamp systems, today's manufacturers are able to supply products with varied features to suit unique and/or custom specifications.

Twin-tube lamp technology generates twice as much UV output as an equal length conventional straight lamp, allowing contractors to provide their customers with higher powered UV units that fit tighter spaces and without drastically increasing cost.

Electronically smart power supplies are a huge advancement over the older magnetic ballast technology. These power supplies can automatically adjust to any incoming line voltage usually within the range of 120-277 volts AC 50/60 Hz. This feature virtually eliminates step-down transformers or other line-conditioning devices. These power supplies run much cooler than magnetic ballasts and are very energy efficient. Most important is that these power supplies deliver a highly consistent flow of current to the lamps that optimize UV output over the life of the lamp.

Other features include high performance electronic circuits that monitor UV lamps. These circuits can inform the operator or consumer of any lamp failure condition and remind when it is time to replace the UV lamp. Most of these systems operate using visual and audible signals for service alert. Ports are also available for the connection of remote alarms and home automation systems that control UV systems installed in attics, rooftops, or in other hard to reach locations.

For maximum safety a UV system should include a cover removal switch or similar remote kill switch that will automatically disengage electrical power when the equipment is being serviced by a technician, thus minimizing risk of UV-C energy exposure and electrical shock.

Maintenance

Typically, maintenance of an ultraviolet disinfection system consists of simply replacing the ultraviolet lamps. The industry standard for lamp replacement is 9,000 hours or approximately one year. There have been no significant advances in ultraviolet technology that would increase lamp life. Over time, a process occurs in UV lamps known as solarization. In effect, the lamps undergo a photo-chemical process of their own during operation. UV lamps are made with a special UV transparent quartz glass (standard glass is not UV transparent) that maximizes output. The UV solarizes the glass, gradually increasing its opacity to the UV frequencies (but not visible light), reducing lamp effectiveness. A common ultraviolet lamp that has been operated 9,000 hours will typically generate 40% less UV-C energy than a new lamp. This is low enough so that disinfection is compromised, and is a good point at which to renew the full disinfection capability of the system by replacing the lamp(s). Newer, high technology lamps are able to maintain a higher percentage of their original UV output over the 9000 hrs lamp life—up to 85% of original output. In addition, the newer lamp designs are much more environmentally friendly, as they use no more than 5 mg of mercury compared to up to 50 mg used in ordinary lamps (which must be disposed of as hazardous waste).

Safety Precautions

There are a few safety precautions to bear in mind when installing and maintaining an UV air disinfection system. The UV-C energy created by the lamps is invisible (although some visible light is generated) and prolonged exposure to it can lead to irritation of the eyes and even to temporary blindness, similar to "flash burn" that can be caused by a welding arc. The system should never be operated outside of a proper installation.

UV lamps share some of the same properties as fluorescent lamps and should be disposed of in a similar manner. Most manufacturers offer lamp recycling programs or lamp reclamation programs. Contact your manufacturer for details.

Always disconnect power to avoid risk of electrical shock before servicing equipment.

About the author

Scott Russell is president and co-founder of Ultravation, Inc. Mr. Russell has been involved with UV disinfection for more than 10 years. His experience includes engineering and design, as well as management in both sales and production. He has dedicated his career to the education and advancement of ultraviolet disinfection technology.

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