Introduction to Use of UV Light For the Control of Air Handler Contamination

By Chris Willette

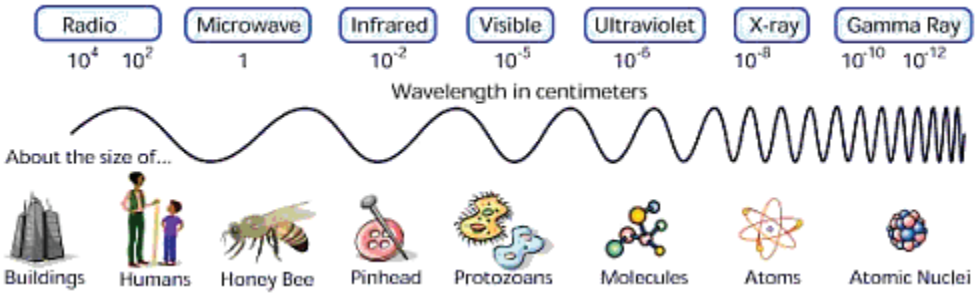
Since the energy crisis of the 70's, we have been forced to build our homes tighter and tighter to save on energy usage. In addition, with the surge in new construction over the past two decades, homes are now built with more and more synthetic or man-made materials. Along with these drastic changes in building techniques comes problems, one in particular is an increase in indoor air quality (IAQ) related illnesses. According to the EPA, indoor air quality is one of the top five environmental health risks of our time.

To address these problems, many companies have tried their hand at solving the IAQ dilemma with the latest and greatest "silver bullet" solutions and have either caused more problems or offered false security. One technology that has proven the test of time, and is growing in popularity, is the use of Ultraviolet Germicidal Irradiation (UVGI) for airborne and surface disinfection and maintenance.

The Use of UVGI dates back to 1909 when it was successfully used to disinfect the municipal water systems in Marseilles, France. In 1936, UVGI was successfully used to sterilize air in surgical operating rooms and in 1937; the first successful application of UVGI to a school ventilation system dramatically reduced the incidence of measles. Today, we find the use of UVGI systems in areas such as bottled water plants, municipal water plants, and sewage plants. And now, with the cost to manufacture UVGI systems becoming more affordable, we are finding UVGI system in use in the home in areas such as water filters, portable air filters (HEPA's), and for the purpose of discussion in this article, in central air handling systems.

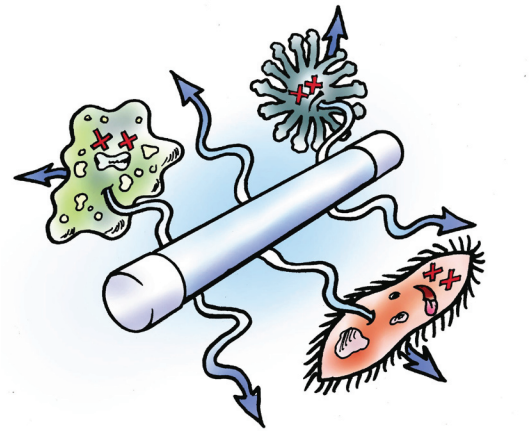
What is UVGI or Ultraviolet Light?

Ultraviolet Germicidal Irradiation or UV Light is an invisible spectrum of light with a frequency just below that of visible light. The range of UV light is between 90 - 400 nm. UV light is most effective at sterilizing when in the "C" band range of 200 – 280 nm.



How Does UV Light Disinfect?

As organic contaminants come into view of the ultraviolet light source, the UV light waves penetrate the membrane and nucleus of microorganisms. The UV light then breaks apart the molecular bonds of the DNA of the microorganism killing the microbe or inhibiting its' ability to reproduce. The amount of UV exposure needed to accomplish this varies from microbe to microbe. Spores, and some environmental bacteria, tend to be resistant and can survive much longer exposures than some viruses and other organic contaminants such as odors.



Application of UV Light Systems into Central Air Handlers

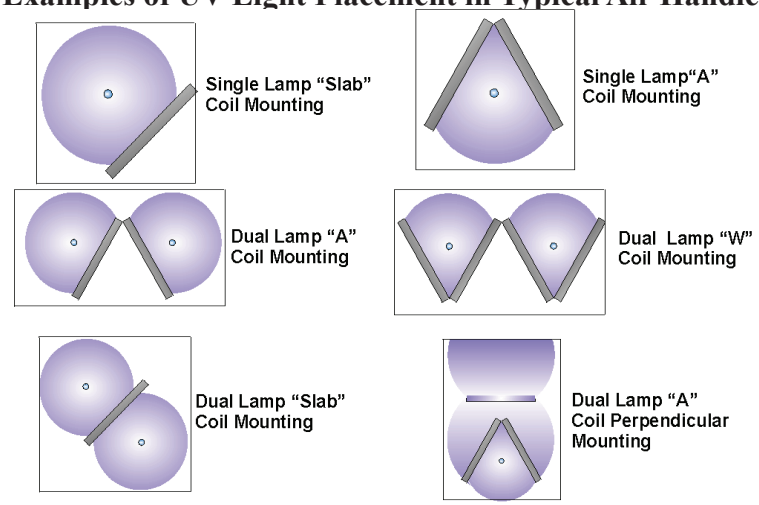
There are two schools of thought on the use of UV light for control of environmental contaminants in a central air handling system. They are: air-stream disinfection and surface disinfection.

Air-Stream disinfection entails targeting the UV Light in the air-stream at a point in the system that allows for sufficient exposure time for adequate exposure to the airborne pathogens. In this case, when you have limited time of exposure due to the velocity of the moving air-stream, more than one UV light unit may be required to achieve adequate exposure time. In commercial applications, this is feasible because there are many places in commercial systems that allow the room to install multiple units, such as at the mixing box between the filter bank and coils. However, in residential applications, this may not be practical due to small ductwork and limited access, and the installation of a single or dual lamp unit may not provide sufficient UV exposure. In reality, control of airborne pathogens in residential applications is not as crucial as in a commercial application such as a hospital or doctors office.

Surface disinfection tends to be a more practical method for typical air handler applications and is the popular application method at present. It is well known that in most cases the contamination of the air handler system stems from the infiltration and growth of organic contaminants in and around the coiling coil and drain pans of the system, which then grow and spread the contamination down the ductwork and into the living spaces. The use of high quality filters can help reduce the opportunity for growth, however strict filter change regimes must be followed or the filters can become clogged causing system damage or allowing contaminates to "cross-over" to the damp components of the air handler where they can flourish.

Incorporating a UV Light system for surface disinfection entails placing the UV light source in an accessible area in the air handler for optimum UV exposure to the coil, drain pans, and other components of the air handler. If properly installed, the UV light system can prevent any growth from occurring within the air handler. And when used in conjunction with other proven IAQ techniques such as filtration, absorption, or de-humidification, can help to drastically reduce the potential for IAQ related illnesses.

Examples of UV Light Placement in Typical Air Handlers



UV Light System Designs

UV Lamp Design and Placement

The ideal UV light system is one that enables the UV light source to be placed in the best location possible, which is typically the wettest location. With this in mind, the light source needs to be "detached" from the power source and the UV lamp and power leads must be waterproofed to prevent shorting out or potential shock hazards. Typical UV Systems available have the power supply and lamps mounted together which prevents mounting in these locations.

In addition, since the ideal mounting locations tend to be the wettest, often times they are the coolest areas as well. Current UV light system designs incorporate the use of un-shielded "hot" cathode lamps that prefer ambient operating conditions around 120 degrees F. The cooling effects of the air stream along with placement near the coil can severely reduce the operating life of these lamps and in some cases damage them. The solution is to either "shield" the lamps from these effects or use a lamp designed to operate in a cold environment, such as cold cathode lamp types.

Lamp Intensity

UV Lamp intensity and Life span are also things that should be considered when evaluating UV light systems. If air-stream disinfection is the approach, then having the most amount of UV production possible is the preferred method, however lamp life can be considerably reduced with higher intensities and damage to internal air handler components and duct material may result. Therefore utilizing a UV lamp that does not considerably sacrifice lamp life for intensity and placement of the UV light source in an area that won't damage materials or

covering those materials with UV resistant covers is advisable.

For surface disinfection, recent studies have supported the idea that direct UVGI exposure can sterilize any surface given enough time. With that in mind, driving the UV lamps for more intensity is not necessary, instead operating them at optimum UV intensities for maximum lamp life is the preferred method. In addition, by operating at lower intensities sufficient enough for surface disinfection, damage to internal air-handler components such as plastic drain pans or wiring can be drastically reduced or prevented.

Lamp Life

Many factors are associated to the overall lamp life of UVGI Lamps. UV lamp manufacturers have developed lamp life ratings for certain types of UV lamps based on set operating currents and ambient conditions. The lamp life rating has been established at a point when the lamps intensity drops to 70% of the lamps original output. This standard was originally developed for the use of UV lamps for water disinfection, as it has been found that if intensities drop below the 70% level, then optimum disinfection may not be achieved. This standard has been adopted for many other UV application, however, to date there has not been a standard developed specifically for IAQ applications. Some typical lamp life spans are outlined in the table below:

Typical Rated Lamp Life-Spans

Lamp Type	**Quartz Type**	**Filament Type**	**Rated Life Span***
Twin Tube Lamp	Soft Quartz	Filament	6,000 hours
“Hot” Filament Lamp	Hard Quartz	Filament	9,000 Hours
High Output “Hot” Filament Lamp	Hard Quartz	Filament	8,000 Hours
Filament Guard Lamps	Hard Quartz	Filament with Cathode Guard	12,000 Hours
Filament Guard Lamps with Ambient Quartz Shield	Hard Quartz	Filament with Cathode Guard	14,500 Hours
Cold Cathode	Hard Quartz	Cold Cathode Electrode	20,000 Hours
Cold Cathode with Ambient Quartz Shield	Hard Quartz	Cold Cathode Electrode	24,000 Hours

* - Life spans rating based on output at 70%

Power Supply

The power supply is a critical component to the optimum operation of a UV Light system. Until recently, the only available option for UV light power supplies has been magnetic ballasts. Aside from being heavy and somewhat clunky, magnetic ballast can drastically reduce the operation and life span of even the best quality UV lamp. With the advancements in electronics in recent years, it has become achievable to incorporate high frequency techniques into the design of solid-state power supplies for UV light systems. In theory, UV light sources are frequency driven device, as the light they produce is a frequency spectrum of light, therefore by utilizing a solid-state high frequency power supply, optimum performance from the UV light can be achieve which increases it's efficiency and life span. In addition, features can be added into the power supply such as automatic voltage sensing for 120-277 VAC, 50/60 Hz and end of lamp life protection.

Safety Precautions

As with any electrical device, installing and servicing these devices should be performed by trained professionals. Power should be disconnected from the unit before any work is performed. Since these devices produce ultraviolet light which prolonged exposure to can cause redness of the eyes or temporary blindness, technicians should be trained in the dangers of working around UV light. Safety features such as remote kill switches or panel safety switches can be incorporated into the UV light systems or into the installation to prevent accidental exposure.

Conclusion

When selecting a UV light system, it is important to understand the differences between the different types of units available and how they can be applied. The old adage that UV systems are just a light bulb and ballast, no longer apply. For proper selection, first understand your application. For commercial applications, air-stream disinfection may be desirable. However, for residential applications, surface disinfection is the preferred method.

About The Author

Chris Willette is president of Triatomic Environmental Inc., which specializes in providing advanced germicidal light solutions for the enhancement of indoor air quality. Chris has been designing and developing products for the indoor air quality industry since 1994, is a published author and has several patents pending, including one for the application of UV light technology into 1" air filter elements. To learn more visit, www.freshaireuv.com.