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Keeping Coils Clean with UVGI

See how energy efficiency and cost savings can be increased with air handlers installed with ultraviolet germicidal irradiation and how to properly size them for a system.

BY CHRIS WILLETTE

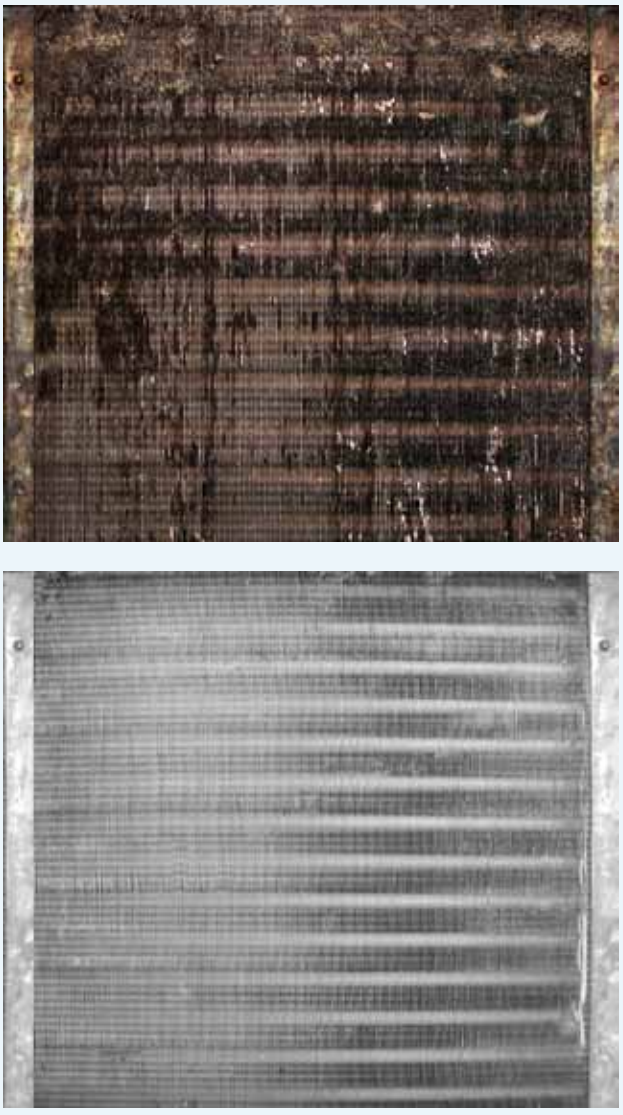
All images courtesy of Fresh-Aire UV.

Like most hospitals, Geary Community Hospital (Junction City, KS) found itself periodically cleaning coils in its original building's air-handling units at an expense of more than $1,500 annually. However, when it built its new $34-million addition four years ago, Steve Rippert, CHFM, GCH's Director of Maintenance, claims the four new air handlers have not needed any cleaning, even though they are checked regularly.

The difference is the new air handlers have ultraviolet-germicidal-irradiation lights that keep the coils clean of mold and other biological contaminants. Dirty coils adversely affect heat transfer and energy efficiency; however biological contamination on coils can affect a facility's IAQ and occupants' respiratory systems.

UVGI has many applications beyond healthcare facilities. Schools, laboratories, offices, industrial facilities, hotels and even residential buildings are receiving green and IAQ benefits from UVGI.

This technology also presents two benefits to contractors: It reduces operational costs while improving a client's indoor environment; and it also offers the opportunity to sell a new or retrofitted HVAC unit to clients. Unfortunately, UVGI capabilities, sizing and installation are still largely misunderstood by many HVAC contractors.



The image on the top is a dirty coil that, left untreated, can affect an HVAC unit's performance. The image on the bottom shows a coil treated with UVGI lamps

Clean coils=greater efficiency

Cost savings on coil cleaning and chemical solvents alone should be enough to entice any facility's owner or maintenance engineer to consider installing a UVGI system in their air handlers. Cleaning cost savings combined with the increased system efficiency due to a clean coil's improved heat-transfer capabilities can potentially produce a payback in as short a time as 6–12 months.

The dark and condensate-rich environment of an HVAC air handler is an ideal breeding environment for mold. Mold commonly grows on coil fins, tubing and also the air handler's interior surfaces.

Studies prove just a .002-in.-thick biofilm on coils can reduce the free area and decrease air velocity up to 9%.

> **Eliminating biological growths can result in a 30% cooling-capacity increase compared to a dirty coil.**

The result is a system with higher static pressure across the coil for which it was designed. Eliminating biological growths can result in a 30% cooling-capacity increase compared to a dirty coil.

Another selling point is the decrease or elimination of toxic cleaning chemicals and biocides. These chemicals are expensive and pose a health risk to maintenance workers and building occupants.

Understanding UVGI benefits

Besides keeping coils and interior air-handler surfaces free of mold, UVGI systems also sterilize airborne biological contaminants as they pass through the system. UVGI has been used for decades to disinfect air and HVAC systems, however until recently, little data was available that supports its effectiveness claims.

A 2012 study by one of the top five international air-cleaner-equipment test labs, Airmid Healthgroup (Dublin, Ireland), actually proved UVGI's effectiveness against mold, bacteria and viruses in a simulated HVAC-unit environment. The study simulated airstream-microbe inactivation in an ASTM-/AHAM-style environmental test chamber. AHG built the chamber to simulate a typical building's indoor environment with an HVAC air handler, providing a 73°F (23°C) temperature, a 55% RH and an air-flow velocity of 492 fpm (0.93 m^3/sec). A single-pass test was also performed on an ASHRAE Standard 52.2 test duct system.

The test's UVGI light single-pass inactivation results were: bacteria (S. epidermidis), 85%–98%; virus (MS2 coliphage), 99.03%; and mold (A. niger), 78.80%.

While someone unfamiliar with these biological contaminants might interpret anything less than 100% as unsatisfactory, the test was only a single pass. Multiple passes, as simulated in a typical HVAC system producing several room air changes hourly, would have produced a greater microbial

inactivation, according to Dean T. Tompkins, Ph.D, P.E., a Milwaukee, WI-based independent IAQ consultant who reviewed the AHG test results.

Since hospitals have the greatest concerns associated with the distribution of airborne pathogens via their HVAC systems, other UVGI research studies have focused on actual healthcare sites. For example, a 2009 Michigan State University study at Ingham Regional Medical Center (Lansing, MI) and its Greenlawn campus, demonstrated significant reductions in airborne bacteria. The study, which was prepared by Marc P. Verhougstraete, Tomoyuki Shibata and Joan B. Rose from the Center for Advancing Microbial Risk Assessment, recorded indoor air levels of viable bacteria and fungi before and after UVGI lamps were installed in an HVAC system.

The study concluded that "average levels (organisms/m^3 air) of total bacteria found in the air prior to the UVGI installation were 45.5 and 25.5" on the Greenlawn and the main campus, respectively. "Average levels of total bacteria found in the air after the UVGI installation were 8.67 and 0.418," respectively.

Proper sizing/installation

Besides these certified third-party test results, contractors also need to know the proper UVGI sizing and configuration methods for the optimum disinfection coverage. Some manufacturers offer online sizing services to assist with any size UVGI light project. The contractor or engineer can simply fill out an online form that prompts many system parameters, such as enclosure dimensions, air velocity and air-handler/coil model.

Output data includes selected lamp model and parameters, number of lamps, lamp locations, UV power, electrical power requirements, each lamp's peak irradiance, in-duct irradiance ($\mu W/cm^2$) and microbe inactivation calculations.

Additionally, some manufacturers use in-house engineers to review each form and assure the resulting UV-equipment recommendations match the HVAC application. A service that goes beyond just software recommendations is helpful when there are unconventional HVAC configurations or an interest in the disinfection of specific microbes.

Some manufacturers also include design and analysis results with color-performance graphs and charts that are printable for proposals and building-owner presentations.

IAQ beyond basic UVGI systems

Manufacturers are now taking IAQ two steps beyond UVGI by supplementing UV with gas-phase air purification with activated carbon media and photocatalytic oxidation technologies.

A 2012 study by Airmid Healthgroup actually proved UVGI's effectiveness against mold, bacteria and viruses in a simulated HVAC-unit environment. The study simulated airstream-microbe inactivation in an ASTM-/AHAM-style environmental test chamber (shown here). AHG built the chamber to simulate a typical building's indoor environment with an HVAC air handler, providing a 73°F (23°C) temperature, 55% RH and airflow velocity of 492 fpm (0.93 m^3/sec).

An important factor in a UVGI system is choosing a non-ballast model with a remote-power supply. A ballast and/or power supply has a shorter lifecycle when mounted in the humid corrosive environment of an air handler. In this photo, the single-pin UV lamps are connected to a remote-power supply via marine-grade, water-resistant connections.

While UVGI is highly effective against biological contaminants, it has no effect on VOCs, such as chemicals found in household cleaners, or formaldehydes, chlorine and d-limonene found in furnishings, paint and coatings. VOCs are known human respiratory irritants that can produce breathing problems, headaches and allergic reactions. Once inside a building from outdoor air or from off-gassing from within, the air handler continually recirculates them.

Manufacturers are now combining UVGI with gas-phase air purification, which is an activated carbon-based material derived from coconut shells, charcoal or wood chips. The carbon media adsorbs and holds VOCs through a chemi-sorption process.

Unfortunately, the carbon media eventually reaches 100% adsorption capacity and loses its effectiveness. Replacing the media can be costly and requires periodic maintenance. Failing to replace it in a timely manner can result in compromised IAQ.

To economically regenerate the carbon media, manufacturers are using the aforementioned PCO. This process uses the same UV lamps that are in place for disinfection purposes. UV lamps stimulate a chemical reaction when shined on titanium-dioxide-infused carbon media. PCO by itself is somewhat effective at reducing airborne VOCs, however using titanium-dioxide-infused carbon media holds onto VOC contaminants and gives the PCO process time to convert them into harmless carbon dioxide and water vapor.

Unlike many conventional air-purification and adsorption methods, the addition of PCO transforms contaminants vs. just holding them on an adsorption substrate. Additionally, this process is effectively performed at ambient temperatures and pressures, thus additional energy to cool or heat the airstream is not required.

Promoting and installing UVGI systems in air handlers benefits the end-user with improved IAQ and reduced coil-cleaning costs. For contractors, UVGI systems can enhance a contractor's reputation for cutting-edge innovation and customer care, and ultimately improve profitability.

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