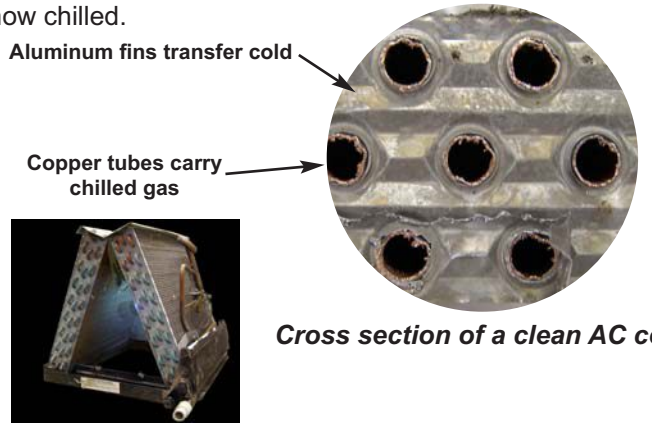
Mold/Bacteria Protection of an Air Conditioner Coil

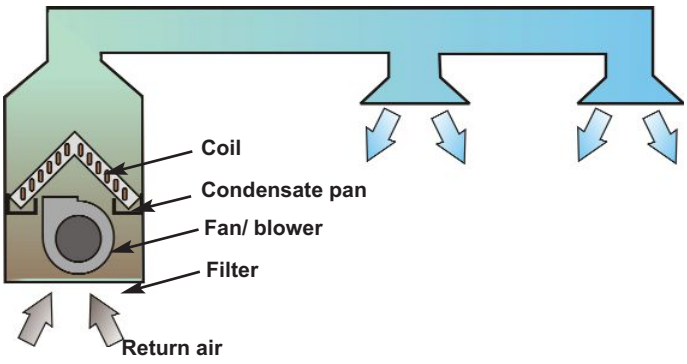
By Ronald G. Fink

The Problem:

Cold gas is pumped through an air conditioner coil. A coil is made up of copper tubing with aluminum fins. The cold gas travels through the copper coil transmitting its low temperature to the aluminum fins, which are now chilled.



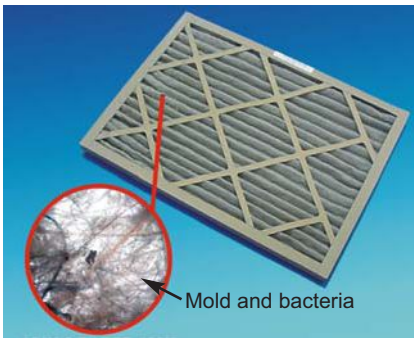
Cross section of a clean AC coil



Return air from the house is filtered and blown through the air conditioner coil fins, which are chilled. The filtered return air is chilled by passing over, under and around the chilled aluminum fins and copper tubing.

The chilled fins condense the moisture out of the return air, much the same as a chilled glass of water. The moisture drips off the fins down to a collector or drip pan where it is drained away as condensate wastewater.

The problem comes to play when the filtered, often not so filtered, return air deposits mold spores and bacteria on the moist coil surfaces (most air conditioner filters will not filter mold spores and bacteria and actually act as a breeding ground for mold and bacteria). As the air conditioner system cycles on and off, the air conditioner gets damp, cold and warm, this wet dark environment is a perfect breeding ground for mold and bacteria. Many forms of mold love this atmosphere in addition Listeria, a bacterium that loves ice bins and air conditioner systems. Listeria is known for its ability to cause large outbreaks of food poisoning in restaurants.

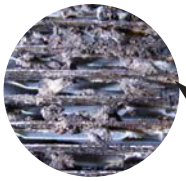


Mold and bacteria build up on an air conditioner coil will give you the following indoor air and other problems:

• Mold Odors

• Airborne Mold
• Increased Allergy Risks
• Increased mold colonization of equipment

• Increase in Airborne Bacteria and associated risk



• Decrease in Air Conditioner Air Flow
• Decrease in Air Conditioner Efficiency
• Reduced equipment lifespan

Cross section of 5 year old Florida ac coil without mold/bacteria protection. 50% air blockage

• Higher Electric Bills

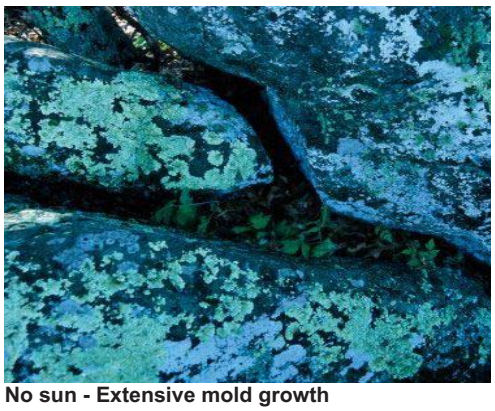
The UV-C Solution:

UV-C Germicidal Lamps

These are rapidly becoming very popular as an easy fix for the air conditioner coil mold problem. This is one of the most prevalent causes of the mold smell you get when you enter an air conditioned sick building. UV-C (254nm) lamps are basically similar to sun lamps and are typically only effective on microbials that pass by within a few inches of the lamp or areas where the light is shining directly on for extended pe-

riods of time, such as the air conditioner coil (see article in HVAC News – June 30, 2003 and Associated Press 11/24/03). Excerpt from article:*"The biggest questions from contractors are on placement, Pharo said. For instance, should UVGIs be installed in the return or supply? For air stream coverage, the study "Defining the Effectiveness of UV Lamps installed in Circulating Air Ductwork," from the Air Conditioning and & Refrigeration Technology Institute (ARTI), recommends placement in the return side, with six lamps for optimum effectiveness, Pharo pointed out. Due to space and financial constraints, however, "Most homeowners won't have that many lamps installed. So we recommend the concurrent installation of a really good filter, with the UV lamp placed over the indoor coil," Pharo said. "Air conditioning systems are great inventions, but the moist environment (at the coils) creates a microbial breeding ground." Additionally, when UV lamps are shining directly on the coils, they are hitting a stationary target. When moving targets (VOCs and microbes) pass UV lights, the more sensitive microbes may be damaged, but the hardier ones will pass unharmed. UV lights, for instance, have been found to be better applied to shine on the indoor coil, not to try to clean the air stream, particularly in residential and light commercial applications; air stream use requires intense UV saturation."* UV-C lights on an air conditioner coil are like the sun shining on a rock by a stream. No mold or mildew will grow on the sunny rock, unlike a shaded rock.

Direct sun - No mold growth



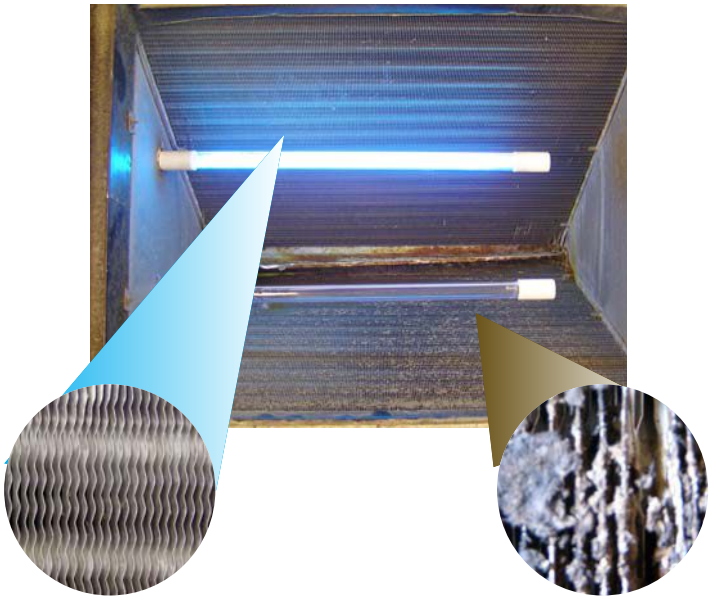
No sun - Extensive mold growth

The main advantages to UV-C lights are low cost, easy installation and effectiveness on suppressing mold/bacteria growth on the coil that has the light shining on it.

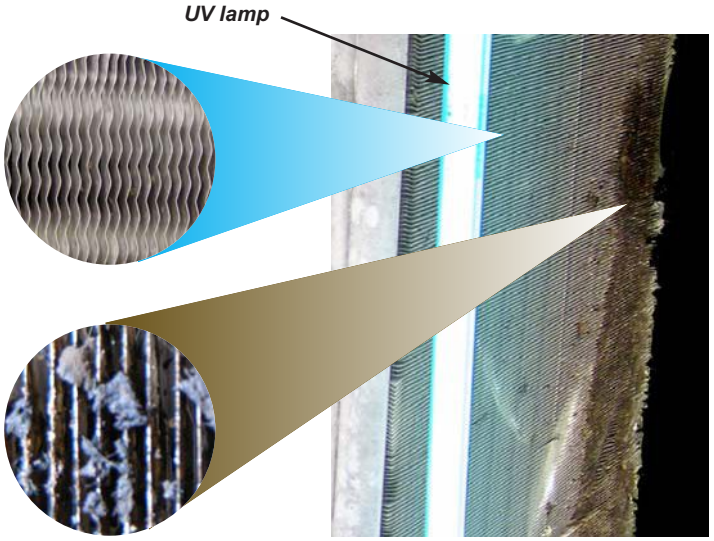
UV-C lights installed correctly can effectively control mold and bacteria growths on the air conditioner coil. They have little to no effect on airborne bacteria, viruses, odors or VOCs unless very large commercial, heavy-duty UV systems are utilized.

The key to good UV/air conditioner coil mold control is the installation. A small air conditioner coil will require a minimum of three UV lights. The geometry of the light and the intensity will dictate the effectiveness. Remember, only the surface the light is shining on will be treated, and only up to 6" to 8" in distance from the bulb. The following are examples of installation:

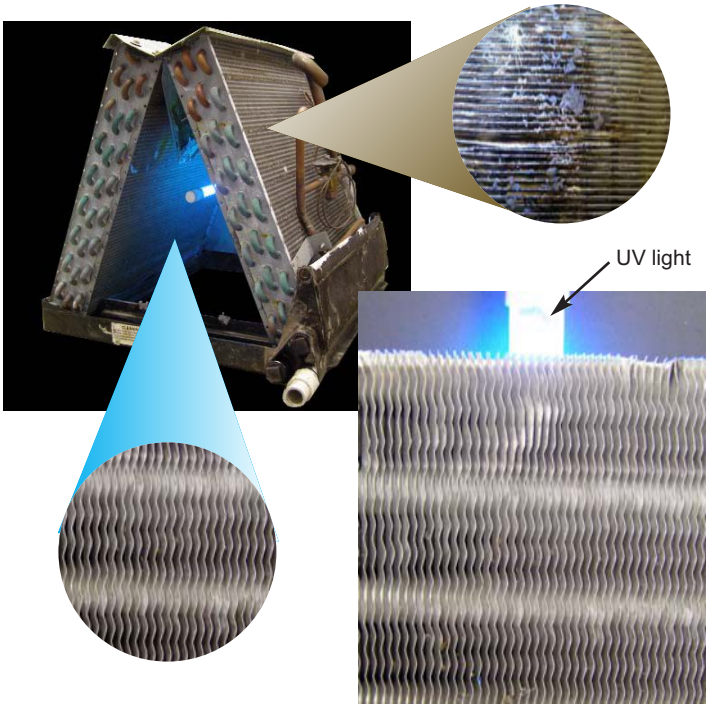
Example No. 1: An eight-year old air conditioner coil with two bulbs properly installed on the inside, one bulb was dead. Note growth next to the dead bulb. The other side is clean. No bulbs were installed on the outside. Accordingly, only one-half of this air conditioner coil was treated. The outside of the air conditioner coil was full of mold and bacteria blocking air flow and creating IAQ problems. This installation is of minimal value to the customer.



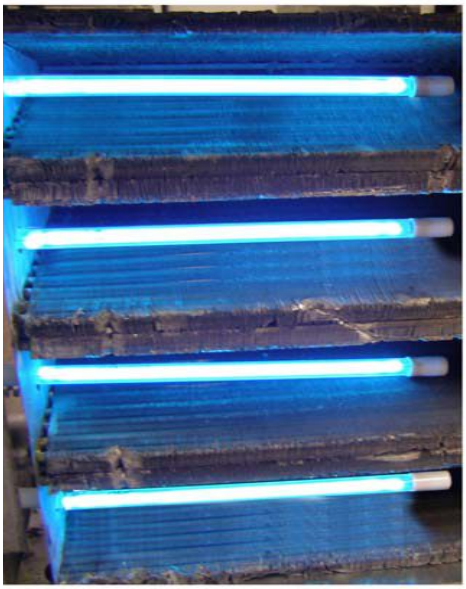
Example No. 2: A ten-year old air conditioner coil with a UV bulb placed too close to the end coil. Most of the coil was clean, but the 25% over 8" away grew mold and bacteria actually blocking air flow of 25%. This installation was of some value to the client, but not 100%.



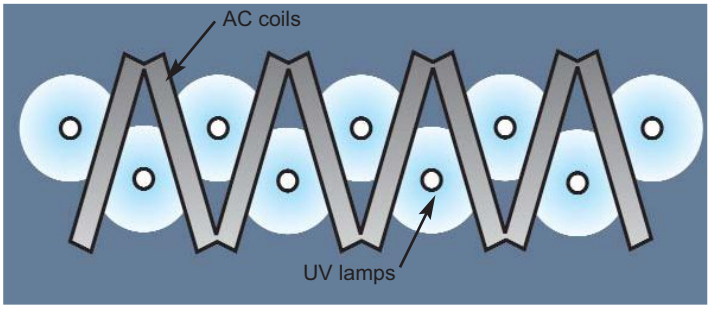
Example No. 3: A small air conditioner coil with one UV bulb mounted in the center. Only one-half of this coil has UV protection as the outer sections have no UV bulbs. Exhibit 3 shows how the light does not go through the coil as the geometry of the fins will not permit it.

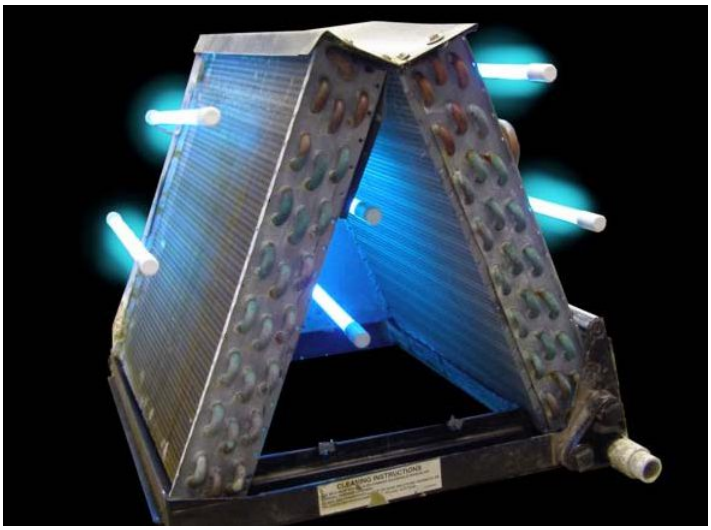


Light will not pass through coils



Example No. 4: A large residential coil could require nine UV bulbs to provide good UV protection for mold/bacteria growth. This will add approximately 300 watts of heat energy to the air conditioner system. However, the mold/bacteria protection and subsequent air flow savings would make this installation worthwhile.





Example No. 5: A large residential AC coil will require 6 lamps for a good coverage. This is an example of an excellent installation.

UV-C Germicidal Lamps On Airborne Microbes

UV has the ability to kill surface bacteria that the bulb is shining directly on at a distance of usually less than six to eight inches. Some UV-C light companies state their UV systems can kill 99.9% of MRSA bacteria on a single pass and then reference an EPA study. This is very misleading as the test was conducted on a test unit of five UV high-energy lamps, each 50” long in a reflective tunnel, which burns 1,100 watts of electricity. This is the equivalent of running a hair dryer in your air conditioner 24 hours a day. This obviously generates a lot of heat in addition to burning a lot of electricity, and the units cost thousands of dollars. This system is not something the homeowner would install. This is an industrial UV system; very expensive, heavy duty systems for food processing or medical applications. The EPA study specifically distinguishes this from UV devices that are designed to treat specific surfaces within the HVAC system; in particular, the cooling coils and the condensate drain pan to prevent biological growth on those surfaces. A standard 12” to 24” HVAC UV light system installed in an air conditioner coil will destroy mold and bacteria growth on the coil surface that the UV light shines on. What sections of the coil the light does not hit will grow mold and bacteria. The UV-C lights used on an air conditioner coil will provide little, if any, airborne microbial kill as the UV energy and dwell or exposure time is not nearly enough to kill fast moving airborne microbials. UV technology is very simple: take a known quantity of UV light and expose a surface or substance to the light for a specified period of time, and a percentage of the microbials are killed. The product of the UV light intensity, multiplied by the time at that intensity, is termed “CT Value”. Tables of CT Values have been published, and are well known. To properly determine what values to use, look in one of these tables and pick a microbe, then read the corresponding CT Value, and design the

Note of caution: Unprotected UV-C lamps were used for this article. In practice, protected lamps should always be used as UV lamps contain mercury, a hazardous heavy metal known to cause health problems. A broken lamp in an HVAC system could permanently contaminate the system.

system around that CT Value. Typical HVAC home systems operate around 2000 cfm for a 2,000 sq. ft. home. For example, 2,000 cfm will have an exit velocity of 500ft/min, or 8.33 ft/sec. From this value, the proper residence time can be evaluated for specific CT values. Typical molds found in households are in the *Aspergillius* family. *Aspergillius* has CT values for a 90% kill ranging from 44,000 to 132,000 uW-sec/cm^2. *Bacillus subtilis*spores, a common bacteria, has a CT value of 11,600 uW-sec/cm2. For example, we will use the *Bacillus* number, because as we will see, that relatively low number will mean a relatively high residence time. CT values higher than *Bacillus* will require an even longer residence time. The lamps can be placed at the outlet or inlet of the coils, however, at this flow rate, you will only have a residence time of 0.24 seconds. That is only 1.7% of the required 14.5 seconds for 90% kill. This is not even close to the required CT Value to kill *Bacillus*. In fact, this value is so small, the UV will have next to no effect on any airborne pathogen.

Ozone

Concern about ozone and HVAC air cleaning devices is often exaggerated. All UV light lamps emit some ozone. UV-C germicidal lamps emit very low levels way below federal safety limits. Many every day items emit ozone such as

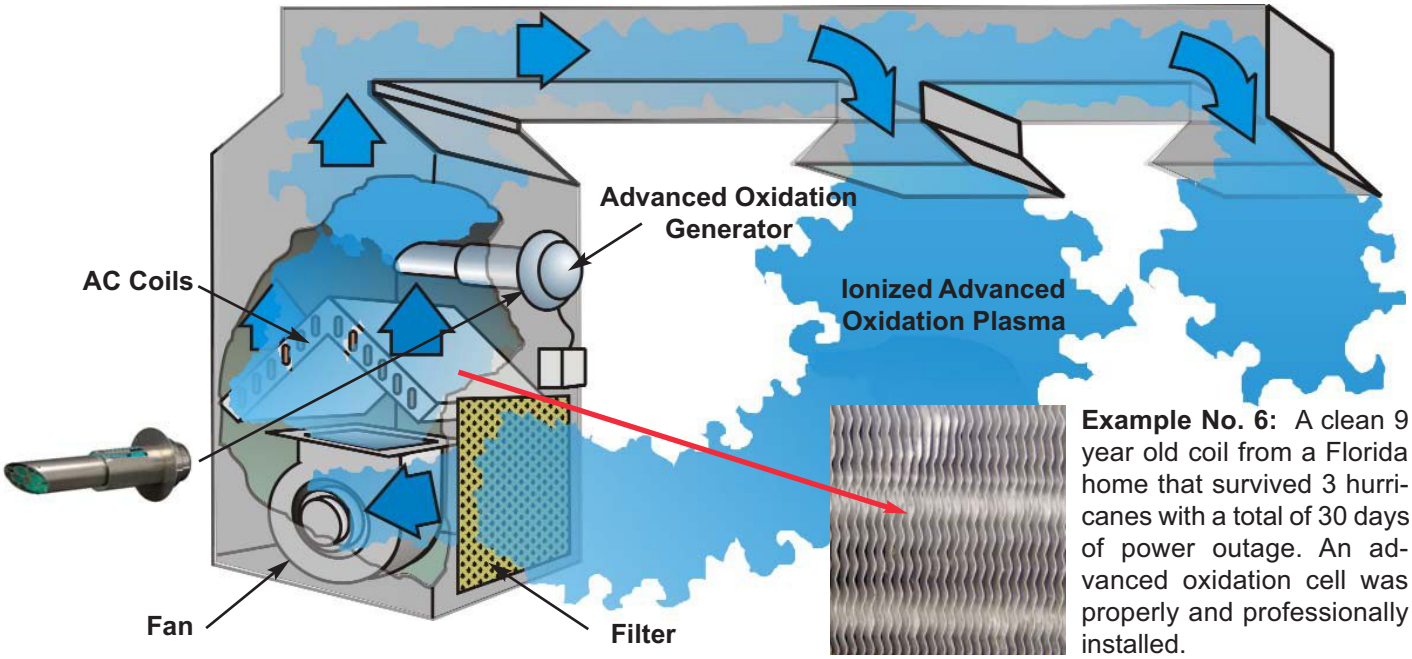
- Fluorescent lamps
- Electric motors
- Copy machines
- Electro static air cleaners

All are within federal safety limits . To pass a UL, ETL or TUV test they must be below .04 ppm of ozone. Outside air is usually higher than this. Example

- .01 ppm ozone becomes detectable to humans
- .04 ppm Federal indoor safety limit
- .12 EPA city safe air limit
- .50 ppm smog alert #1
- 1.0 ppm smog alert #2

The Advanced Oxidation Solution

The Advanced Oxidation Plasma will destroy mold and bacteria growth on an air conditioner coil and the air filter. The plasma, being a gas primarily made up of ionized hydro-peroxides, will achieve full coverage as it moves in and around the air conditioner coil fins and through the air filter, controlling mold and bacteria growth.



Example No. 6: A clean 9 year old coil from a Florida home that survived 3 hurricanes with a total of 30 days of power outage. An advanced oxidation cell was properly and professionally installed.

Silver Nano Coatings

A new technology is a silver nano coating on the AC coil and drip pan to prevent microbial growth. Copper and silver are both good controllers of bacteria and mold. Silver has been used for centuries for bacteria control. In medieval times wealthy families would put a silver spoon in the mouth of babies after feeding to kill bacteria and prevent food poisoning. Hence the phrase “silver spoon baby”. Silver nano is a promising new possibility for low cost control of bacteria and mold.

Silver

Copper

About the author: Ronald G. Fink - President and CEO RGF Environmental Group, Inc.
Mr. Fink holds a BSME and has been active in UV and Nuclear Energy since the 1960s. He holds numerous patents and authored over 70 articles.
RGF Environmental Group, Inc. founded in 1985 manufactures over 500 products involving UV, Advanced Oxidation and Silver Nano Coatings.