

Pathogen protection of air systems through UV-C disinfection



The Problem

As the world is struggling to respond to the coronavirus disease (COVID-19) pandemic and engineering solutions are sought to protect people and the spaces they occupy. The American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) recently made statement ^{REF 1} on airborne transmission of SARS-CoV-2....

Transmission of SARS-CoV-2 through the air is sufficiently likely that airborne exposure to the virus should be controlled. Changes to building operations, including the operation of heating, ventilating, and air-conditioning systems, can reduce airborne exposures.

Various studies show that aerosolised Covid-19, like its predecessors SARS and MERS can last hours in the air and has been found inside AC systems. ^{REF 2, 3 & 4}

Most of the world's population spends a large percentage of their time indoors; in homes, schools, offices, and factories where air conditioning (HVAC) is relied upon to keep people at a comfortable temperature. This worldwide reliance on conditioned air does have its issues though...

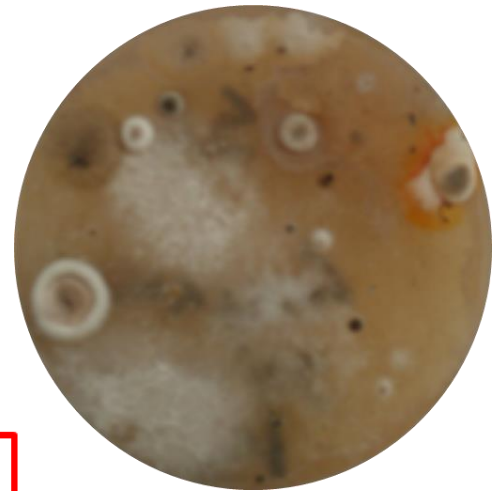
The electricity cost to heat and cool most modern buildings ranges between 50-70% of the power bill. But more importantly there are health issues to contend with. You often hear people say...

“It’s the air-conditioning making me SICK!!!”

And when you see what grows in the average AC system you will know why!



**Agar plate testing
grown off an AC coil
in a medical device
production facility**



Moulds

Bacteria

From the opening day of a brand new air conditioning building its Air Handling Units (AHU's) and Fan Coil Units (FCU's) will have a variety of pollutants including dust, dirt, pollens plus microscopic organisms; moulds, algae, and yeast brought in through fresh air intakes, along with bacteria and viruses transported from occupants through the return air ducts. Many of these units are fitted with a medium grade filtration to capture the bigger particulates before the coils, but certainly not microscopic pathogens.

The ultimate goal of any life form is to find a secure place to settle, colonise, flourish and then spread to other regions, therefore many of these opportunistic pathogens find an idyllic home on an AHU's cooling coil being that it's a moist, dark, dank environment... Where do you grow mushrooms?!?! If the first microbial colonists are not immediately removed from the surface, they will anchor themselves permanently using cell adhesion molecules called pili. The first colonists facilitate the arrival of other cells by providing more adhesion sites and building the matrix to form a biofilm colony.

Once colonization has begun, the biofilm grows through a combination of cell division and recruitment and form into a complex aggregation of micro-organisms. Biofilms are usually found on solid substrates submerged in or exposed to an aqueous solution (condensate), and given sufficient resources for growth,



will quickly grow to be macroscopic. Bacteria and viruses living in a biofilm usually have significantly different properties from free-floating bacteria of the same species because the dense and protected environment of the film allows them to develop increased resistance to detergents and antibiotics, as the dense extracellular matrix and the outer layer of cells protect the interior of the community. This is why traditional HVAC coil cleaning is so ineffective in permanently removing biofilm off the entire fin surface area.

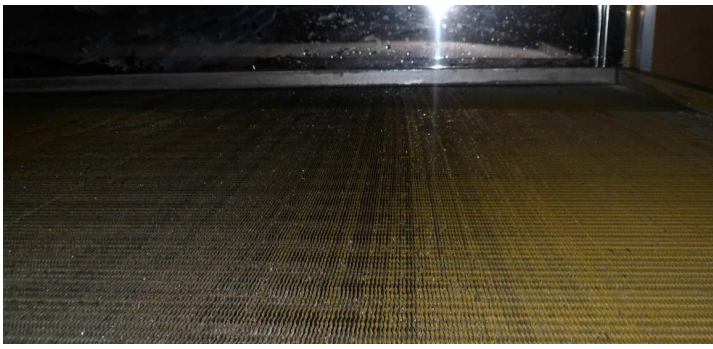
As the biofilm grows over the surfaces of the metal fins it drastically affects both the airflow and the heat transfer of the coils meaning required thermal efficiencies cannot be provided throughout the building. The biofilm's sticky surface readily attracts and holds any airborne particulates further fouling the limited fin spacing. As the coil fouls the internal environment the AHU serves becomes stuffy and uncomfortable leading to the building technicians to lower the setpoints in an attempt to achieve desired internal temperature. This in turn puts more load onto both the fans and chillers that are now required to run faster and longer to achieve the desired temperature. Ultimately this leads to higher operational energy costs that may be hidden from general notice as they incrementally creep up. The biofilm also releases spores and waste products in the form of VOC's that travel through the supply air and can have a negative effect on room occupants. Many of the smaller pathogens can and will surpass the even high-grade filtration to then contaminate the occupied rooms via the supply air ducts. Occupant exposure to these pollutants can result in skin rashes, odour nuisance, breathing difficulties, and increased sickness resulting in increased absenteeism. The average company spends around 3-5% of its annual budget on energy, and almost 80% on its people!

The Solution – High Energy Germicidal UVC Energy

Pathogens do not survive well in sunlight due to the UV light that gets through to the OZONE layer and is the reason mushrooms and moss grow on the south side of trees where they are shielded from the full intensity of the UV rays. Mainly it is the UV light in the 'C' spectrum that is germicidal where it actually disrupts the RNA/DNA of microbes to the point of killing them.

We bring this same power of the Sun into the indoor environment and harness the germicidal attributes of UVC light to eliminate the free-floating microbiological contaminants traveling in the airstream while also attacking the built-up biofilm on the coil itself. UV Solutionz High Energy UVC lamps are easily retrofitted into existing AHU's, FCU's or even domestic heat pumps.





Biofilm growing on coil before UVC exposure



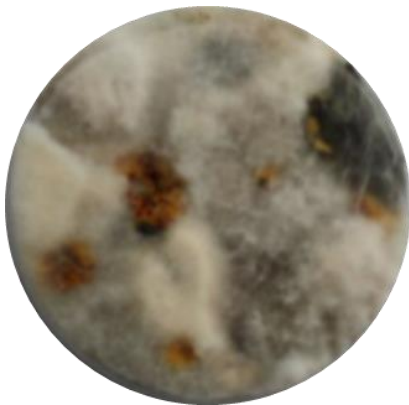
Coil after 60 days of UVC exposure



Microbial samples taken from Coil surface before UVC



And then after 60 days continuous operation



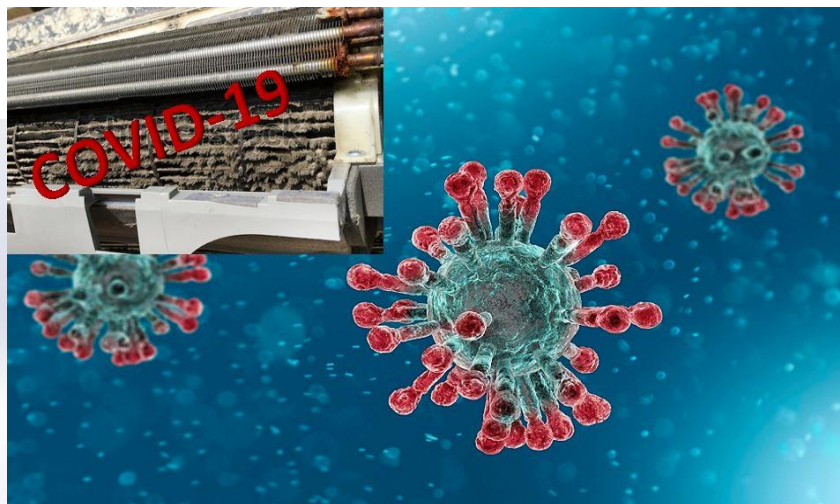
Microbial samples taken from drain pan before UVC



And then after 60 days continuous operation

The lamps continuously bathe the coil in High Energy germicidal UVC light that kills the biofilm on the leading edge causing it to lose its grip on the metal surface allowing the condensate moisture created by the cooling process to wash it and any adhered particulates with it into the drain pan. As the biofilm on the leading edge is removed the UVC light reflects off the now clear metal fins allowing deeper penetration through the coil until ultimately the coil is cleared of all remaining biofilm and fouling contaminants from front to back completely. This will after a short time (1 to 6 months) return the system back to its original designed performance. As a result of the now clear coil and the heat transfer improved, the VSD fitted fans and chillers will not work as hard meaning energy consumption will reduce. The system's performance is then perpetually kept optimally efficient through the installed UVC lamps which are then replaced every 18 months. A post recommissioning process is advised once the system has operated for a while as the building engineer will now get complaints from occupants stating that 'it's too cold!'... This indicates that the plant is now back to its original commissioned set point. During this recommissioning process it is often discovered that the chiller temp can be raised leading to a direct energy saving upwards of 4%. Generally, our achieved ROI's fall between 1 and 2 years depending on cooling load, age of AHU and level of contamination/fouling.

But what about Covid-19? Can UVC kill it?



Short answer is YES, however to date there has been little to no research on the efficacy of UVC against Covid-19 specifically, although there has been plenty of evidence based research on other pathogens including viruses which are generally the easiest to inactivate. ASHRAE ^{REF 5} has identified only three engineering controls that have been demonstrated to reduce risk of airborne infections – extra ventilation, high efficiency particulate filtration, and UVC.

We have developed air systems designed around a first pass kill on specific pathogens like Anthrax, however as stated we do not at this stage have the engineering data to reliably design a system to combat Covid-19 on a first pass kill basis.

The installation of UVC is only part of the 'Good Hygiene practice' equation, UVC can do what filters cannot in the way of continuous coil cleaning and disinfection while also reducing bio loading of downstream ducts and filters. Different pathogens require varying degrees of irradiance to inactivate. The good thing is that dosage is cumulative meaning that even though most systems cannot kill (not enough lamps) of first pass a return air system is likely to be clear after only a few air exchanges.

About us

UV Solutionz Limited based in New Zealand's beautiful Bay of Islands is a SME tech company specialising sustainable engineered solution technologies throughout the NZ, Australia and the South Pacific for a diverse range of industries including Hospitals, Universities, Military installations, Foodtech and Pharmaceutical facilities, Casinos/Hotels and Government institutions. UV Solutionz flagship technology is their own system designed high energy Germicidal UVC lamp, ballast and housing combination that has been specifically engineered to deliver a maximum output dose in cold moving air. All systems have been verified compliant to AS/NZS 60598.2.1 & AS/NZS 61347 for Electrical Safety and have been tested for optimal performance by the NZ Government's Measurements and Standards Laboratories - MSL (<https://www.msl.irl.cri.nz/services/photometry-and-radiometry>).

REF 1 <https://www.ashrae.org/file%20library/technical%20resources/covid-19/eiband-airbornetransmission.pdf>

REF 2 COVID-19 Outbreak Associated with Air Conditioning in Restaurant, Guangzhou, China, 2020

https://wwwnc.cdc.gov/eid/article/26/7/20-0764_article

REF 3 <https://www.newshub.co.nz/home/world/2020/03/coronavirus-covid-19-samples-found-in-isolation-room-air-vents.html>

REF 4 <https://www.who.int/news-room/commentaries/detail/modes-of-transmission-of-virus-causing-covid-19-implications-for-ipc-precaution-recommendations>

REF 5 https://www.ashrae.org/file%20library/technical%20resources/covid-19/si_a19_ch62uvairandsurfacetreatment.pdf

Please visit www.uvsolutionz.co.nz if you'd like to know more

"To know even one life has breathed easier because you have lived. This is to have succeeded."

- Ralph Waldo Emerson

