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UV-C disinfection
air purification

It’s time to breathe healthier air

Philips UV-C disinfection technology is the fast and effective way to reduce the risk of coming into contact with harmful micro-organisms

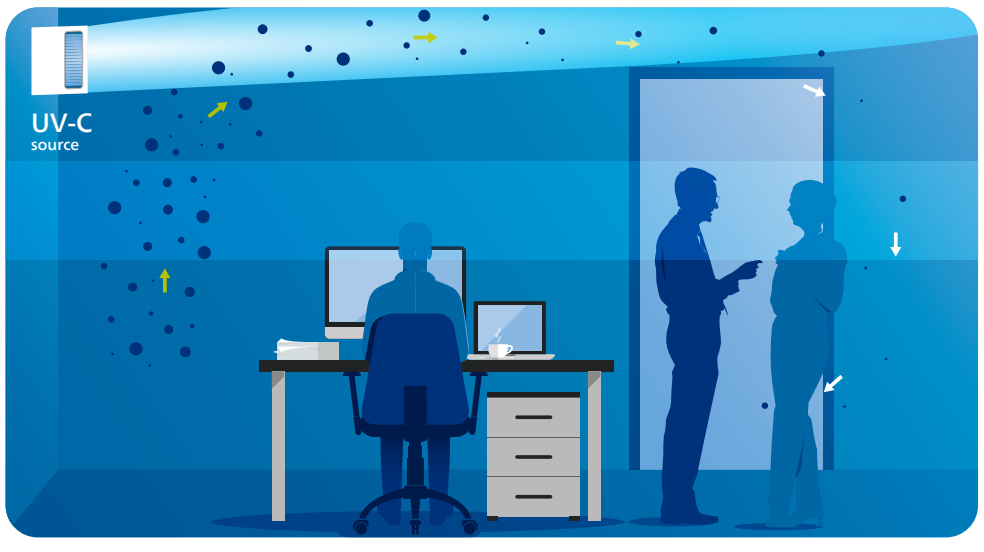
innovation you

Protect against viruses and bacteria with UV-C lighting

The quality of the air we breathe has a profound effect on our health and well-being. Improving indoor air quality (IAQ) should therefore be given our highest priority. Because bacteria and viruses that are transported by the air can cause a wide range of common infections.

Indoors, especially when there are a lot of people present, the likelihood that there are micro-organisms in the air is high. The risk of acquiring an infection from those micro-organisms increases according to a number of factors: the amount of time a person spends in a room, the number of infected people, the nature of their activity (singing, talking, exercising etc.), and the infectiousness of the organism (e.g. Delta vs Omicron variants of COVID-19).

But there is a simple way to reduce the risks – by treating the air with UV-C radiation.



What are micro-organisms?

Micro-organisms are living organisms and can be either bacteria, yeasts, fungi, viruses or single-celled parasites. They are too small to see with the naked eye, but are present everywhere - in the air, in (natural) water, in our food and in and on animals. Some of these micro-organisms can cause diseases and can be transmitted via the air, such as SARS-CoV-2, tuberculosis and measles.

What is UV lighting?

Ultra-Violet (UV) radiation is invisible to the human eye and is divided into UV-A, UV-B and UV-C. UV-C radiation has been shown to effectively break down the DNA of micro-organisms, which renders them unable to replicate and cause disease.

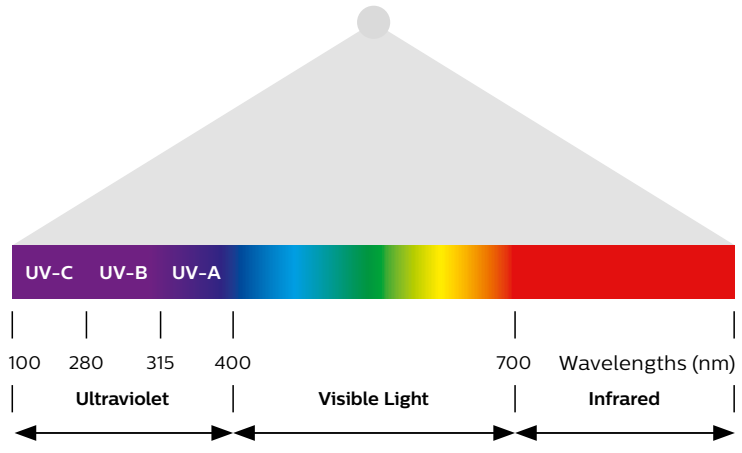


Figure 1: The Electromagnetic spectrum

The importance of treating indoor air

Indoor air needs to be treated to enhance the comfort of the people who live or work there. Not only should temperature and humidity be in their comfort zone, indoor air quality should also be at an acceptable level. No bad odors, harmful substances or dust should be present in the air. This includes nanoparticles, chemical substances and micro-organisms that are transferred from the air outside, or are generated inside the building.

Micro-organisms in the air can be generated by construction materials (mold) but typically come from infected people in the building. When an infected person is present in the room, the concentration of micro-organisms suspended in the air (aerosolized) will increase until the number of micro-organisms generated per minute is equal to the number of micro-organisms removed per minute. Once the infected person leaves the room, the concentration will decrease exponentially. This will also depend on the room being ventilated with fresh, uncontaminated air, or other contaminant removal systems.

Air changes per hour

The ventilation in a room can be expressed in air changes per hour (ACH). This is the amount of clean air that is brought into the room per hour, compared to the total air volume of the room. The graph below demonstrates that a higher ACH - based on perfectly mixed air - results in less exposure to the contaminant.

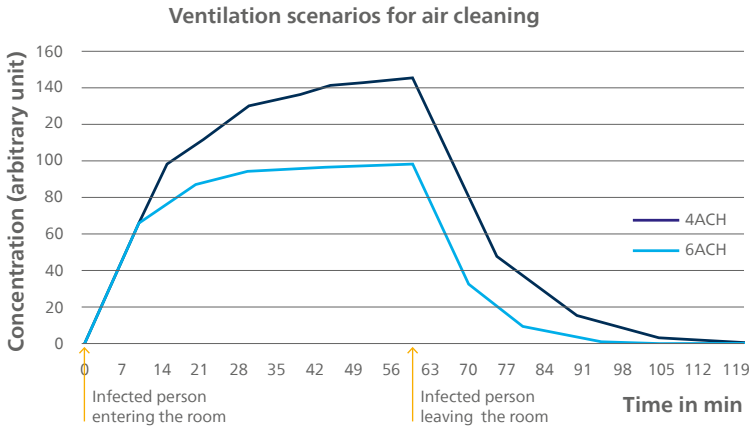


Figure 2: Ventilation scenarios for air cleaning

How clean is the air we breathe?

If an infected person is in the room, other people can get infected by breathing the contaminated air. The risk of infection depends on several factors such as time of exposure, a person's susceptibility, the number of infected persons, and how contagious the virus is.

The number of contaminants and their contamination time can be directly influenced by air treatment. Some of the micro-organisms will settle on the ground, while others will stay in the air for a longer period (so-called aerosols). These aerosols can be removed with air treatment. Ideally, this should remove micro-organisms as quickly as possible, since this will reduce the total dose inhaled by people in the room.
The speed of contaminant removal will depend on:

- the amount of clean air brought into the room per hour compared to the total air volume of the room
- how efficiently the air is mixed
- how efficiently the air treatment device deactivates micro-organisms in the air of the room.

How long does it take to remove contaminants?

The clean air used to dilute the contaminated air can come from outside, or from recirculated air that has been disinfected prior to re-entering the room. The table below shows the time required to remove the contamination, when there are no infected people present in the room.

Air changes per hour (ACH)	Time required to remove percentage of contaminants (minutes)		
	90%	99%	99.9%
2	60	138	207
4	35	69	104
6	23	46	69
10	14	28	41
20	7	14	21
50	3	6	8

Table 1: Air changes and time required to remove airborne contaminants[1]

This table is based on perfectly mixed air (mixing factor 1). The higher the mixing factor, the longer it takes to reach the same disinfection effect.

Equivalent air changes per hour

UV-C technology can be used as an alternative to filtration (or in combination with filtration) for treating recirculated air in the ducts of a HVAC system, or for in-room air treatment. UV-C air treatment deactivates the micro-organisms in the air instead of physically removing them. Ultimately, the effect will be the same as physical removal by dilution or filtration since deactivated micro-organisms will not make people sick.

The performance of UV-C deactivation is expressed in equivalent air changes per hour (eACH). This is the number of air changes with fresh (not contaminated) air that would be required to have the same reduction in micro-organisms as UV-C deactivation.
In the case of in-room air treatment, these eACH work in tandem with the ACH from ventilation air treatment. The result is that air in the room is cleaned much faster than by ventilation alone.

One of the most efficient ways to use UV-C is to disinfect the upper air in rooms. This has a proven track record of drastically reducing infections in tuberculosis patient rooms[2]. It can deliver equivalent air exchanges of 15 eACH or more, which is very cost effective compared to using air ventilation for the same purpose.

To find out more about the benefits of using Philips UV-C technology to improve your air quality, contact your Signify representative, or go to www.lighting.philips.com/main/products/uv-disinfection/uvc-lamps

References:
1. Table S3-1, CDC Guidelines for preventing the transmission of Mycobacterium tuberculosis in health-care facilities. MMWR 1994
2. Mphaphlele, Dharmadhikari, Jensen, et al.: Trial of Upper Room Ultraviolet Air Disinfection
3. Evergreen UV, www.lumalier.com

Three ways to disinfect air with UV-C technology

Air in a room can be disinfected using upper air systems, air re-circulators or via the HVAC system

Upper air UV-C devices are designed to generate a controlled UV-C field above the heads of occupants while minimizing UV-C in the lower occupied area of the space. In the upper part of the room, air is continually disinfected as it moves around the space by natural convection or mechanical ventilation.
A very high eACH rate (>15) can be achieved by a well-designed upper air system, providing good disinfection of the space in a short period of time, as can be seen in Figure 3.

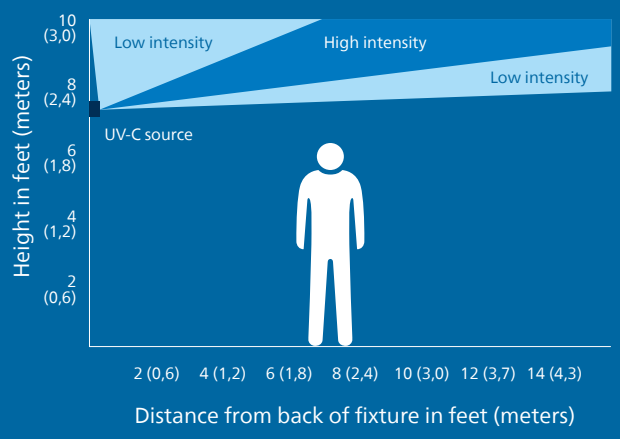


Figure 3: Upper air disinfection

Air re-circulators are devices that are placed in a space to act as a stand-alone air handler. In these devices, air is pushed mechanically through the system and is disinfected as it passes through a filter and/or UV-C chamber. Any contaminated air that enters the re-circulator is expelled as disinfected and/or purified air. Depending on where the device is placed, and the air mixing in the space, eACHs can be increased with good results for air disinfection. In fact, a re-circulator can realize a maximum of 10 eACH.

Figure 4: UV-C air disinfection floor standing unit

UV-C fixtures installed in **air-handling-unit (AHU) plenums, air-distribution systems, or HVAC ductwork** are designed to inactivate micro-organisms "on the fly." In a HVAC system, UV-C should be installed as a basic system to maintain the cleanliness of cooling coil surfaces and condensate pans. To safeguard the efficiency of the system, UV-C lamps must be installed in close proximity to the coils. In addition, for systems that mainly use re-circulated air, UV-C should be installed in the duct, so the radiation can be distributed uniformly in all directions throughout the length of the duct.

Figure 5: HVAC system[3]