Facts and FAQs

Can air cleaners effectively remove airborne viruses in rooms?

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The answer to this question depends on:

1. The **efficiency of the filters** in the air cleaner in removing microscopic particles that pass through the air cleaner. This efficiency can be further enhanced by adding **germicidal** properties (such as UV-C irradiation) that kill or inactivate microscopic biological particles such as viruses and bacteria.
2. The **air flow rate** in cubic feet per minute (CFM), so how much air is recirculated through the device …. on a normal use setting at acceptable noise levels.
3. The **volume of the room** in cubic feet, so how many air changes per hour (**ACPH**) are achieved in the room by the air cleaner.

   ACPH = 60 / (room volume / air flow rate)
4. The **airflow directions** (the way the air cleaner sucks in the room air and blows out the clean air) and the **placement** of the air cleaner **in the room.**

The **efficiency of the filters** depends on the size of the particles. It is the very small particles that are of most concern to human health as they can get down to and lodge in the lungs. The graphic below shows the relative sizes of some particles.

A standard rating for filter efficiency is the Minimum Efficiency Reporting Value (**MERV**). The test that determines a filter's MERV rating tests three different size ranges of particles: 0.3 - 1.0 µm, 1.0 - 3.0 µm, 3.0 - 10 µm. A filter with a **MERV rating of 13 or better** is efficient at capturing airborne viruses.[1] Examples of the efficiencies in the three particle size ranges are:

MERV rating	0.3 - 1.0 µm	1.0 - 3.0 µm	3 - 10 µm
13	50%	85%	90%
16	95%	95%	95%

High Efficiency Particulate Air (**HEPA**) filters are tested to a different standard and have a higher efficiency than MERV 16 filters. By common definition in the United States, HEPA filters remove at least 99.97% of 0.3 µm particles. However, under international standards there are a number of HEPA classes based on the % removal efficiency of the most penetrating particle size (MPPS), which are typically smaller size than 0.3 µm:

HEPA class:	H-11 (or E-11)	H-12 (or E-12)	H-13	H-14
MPPS removal efficiency	95%	99.5%	99.95%	99.995%

The table below shows the test data for an illustrative example H-13 rated filter:

Particle size range(µm)		0.10-0.15	0.15-0.20	0.20-0.25	0.25-0.30	0.30-0.50	0.10-0.50
Sample No.	Δ Pa	Fractional efficiency (%)					Efficiency (%)
22-0033-01	44	99.982	99.995	99.998	99.999	99.999	99.992

To address the air flow rate part of the effectiveness question, a rating has been developed by the Association of Home Appliance Manufacturers (AHAM) called the **Clean Air Delivery Rate** (**CADR**). The CADR rating reflects the volume of air that is cleaned of particles of certain sizes. To measure the effectiveness in removing different particle sizes, three types of particles are tested: smoke (0.09 - 1 µm), dust (0.5 - 3.0 µm) and pollen 5 - 11 µm). These represent small, medium and large sized particles. Each is measured and assigned its own CADR score. The advantage of the CADR rating is that it gives the consumer a way to compare air purifiers that considers both air flow and filter efficiency.

The CADR is basically the air flow (CFM) times the efficiency of the air filter. So, if an air filter has 200 cfm and 100% efficiency the CADR would be 200. If the air filter has 200 cfm and 75% efficiency the CADR would be 150. The CADR is a good way to keep from being misled in marketing messages. For example, if a filter has a very high filter efficiency but low air flow (or vice versa) the CADR helps to balance the two.

In general, larger rooms and spaces require units with higher CADR ratings. The US EPA recommends the following minimum CADR values to provide at least an 80% reduction in steady-state particle concentrations.[2] The table below shows these values, and also calculates the equivalent minimum clean **air changes per hour (ACPH),** assuming 9ft ceilings.

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[1] ASHRAE https://www.ashrae.org/technical-resources/filtration-disinfection

[2] US EPA https://www.epa.gov/sites/default/files/2018-07/documents/residential_air_cleaners_-_a_technical_summary_3rd_edition.pdf

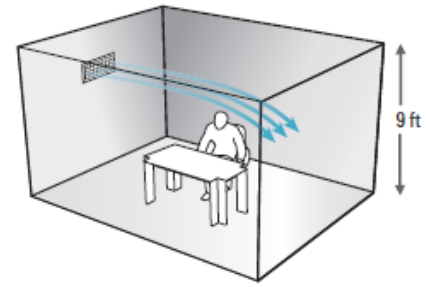
Room Area (sq. ft.)	100	200	300	400	500	600
Minimum CADR (cfm)	65	130	195	260	325	390
Minimum clean ACPH	4.3	4.3	4.3	4.3	4.3	4.3

The **placement of the air cleaner in the room** can also play a major role in how effective it will be. Connected to this is the design of the air cleaner – how it sucks in the room air and discharges the cleaned air back into the room. The objective is to promote an air circulation pattern that reaches all parts of the room. One key issue in controlling the spread of viruses and similar infectious aerosols is that **the air cleaner should not blow air at or across people in the room and then onwards to other people**.

Regular heating and cooling ventilation systems are designed to project air from the discharge grilles above the people occupied zone.

Ideally, to emulate this design, room air cleaners should be tall with the air discharge being horizontal at the top.

If air cleaners are not tall, they should discharge the air vertically and draw it in horizontally at a low height. This emulates a traditional sill type HVAC system and can create an air mixing circulation pattern that avoids blowing air directly at the people occupied zone.



Are air cleaners with HEPA filters the most effective for viruses?

Not necessarily. While HEPA filters have the highest efficiencies at 0.3 µm (99.97% versus 95% for a MERV16 filter) they can have drawbacks. They have higher pressure drops, especially as they load which means the flow rates of the air cleaners are reduced. The filters typically have high replacement cost so users may not replace them as quickly as they should to maintain adequate flow rates. The reduced flowrates mean lower ACPH so lower effectiveness in their operation. The CADR rating concept helps to understand why having the highest efficiency filters does not automatically mean the most effective air cleaner.

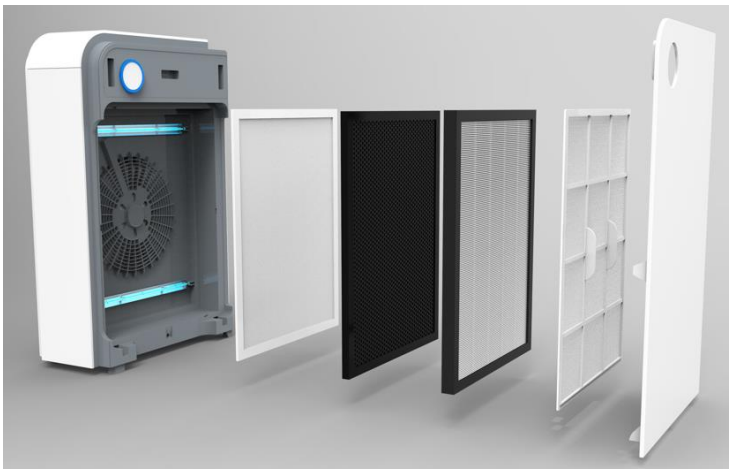
For heating, ventilation and air conditioning (HVAC) systems ASHRAE recommends the layering of mechanical filtration using the highest practical MERV filter with UV-C disinfection. This increases overall air cleaning through capture and/or viral inactivation. UV-C radiation is a short wavelength ultraviolet light that has strong germicidal properties. Ultraviolet germicidal irradiation (UVGI) is a **chemical-free disinfection method that uses UV-C light** to kill or inactivate microorganisms by destroying nucleic acids and disrupting their DNA, leaving them unable to perform vital cellular functions. UV-C radiation has been scientifically proven over many decades in hundreds of studies to kill and inactivate harmful microbiological pathogens including, most recently, the SARS-CoV-2 virus that caused the COVID-19 pandemic. The **Ultraviolet Germicidal Irradiation Handbook** lists data for over 600 microorganisms (bacteria, viruses and fungi) studied under various UV radiation sources. A useful summary list can be found here.

The majority of modern UVGI lamps create UV-C energy with an electrical discharge through a low-pressure gas (including mercury vapor) enclosed in a quartz tube, similar to fluorescent lamps. Roughly 95% of the energy produced by these lamps is emitted at a near-optimal wavelength of 254 nm.

For in-duct air disinfection systems involving banks of UV-C lamps ASHRAE suggests a **conservative minimum UV-C dose value of 1,500 µJ/cm^2 for 99% inactivation of SARS-CoV-2 in air**.[3]

In-duct UV-C air disinfection system

Standalone room air cleaners can also include **UVGI** systems to enhance the efficiency achieved by the mechanical filters. Even the most efficient HEPA filters are not 100% efficient and their efficiency can degrade as they load up. UV-C irradiation can kill or inactivate the microbiological organisms that get through. An example of this layered approach to effective air cleaning can be seen in this small portable air cleaner which includes a pre-filter, an H13 HEPA filter, an activated carbon filter, a photocatalyst filter, two UV-C lamps and an ozone free anion generator.



The photocatalyst filter is a recent innovation in air cleaners. This works in conjunction with the UV-C lamps. A photocatalyst is a coating agent containing titanium dioxide as its active component. An oxidation-reduction chemical reaction occurs when light comes into contact with the photocatalyst. The UV light works with the photocatalyst to degrade harmful substances, such as formaldehyde and benzene in the air.

Click here for information on Greenlight Canada's Air Cleaning and Disinfection products.
Or send us an email to contact@greenlightcan.ca

Our product range includes our own UVY brand UV-C air purifiers and disinfection chambers designed and manufactured in Vancouver, plus other ceiling mount, wall mount and portable air purifiers manufactured by our supply chain partners.

[3] ASHRAE https://www.ashrae.org/technical-resources/filtration-disinfection