Recommendation from the Nordic Ventilation Group

Criteria for room air cleaners for particulate matter

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Introduction

Portable air cleaners can be used to reduce the concentration of particulate matter in room air. They may also reduce the risk of infections due to pathogens in the indoor air, as a significant amount of viral material is spread as small droplets or dried droplets which behave like small airborne particles. These viral particles can be removed from room air using portable air cleaners, by circulating the air through the unit. To be safe and effective the cleaner must fulfill certain performance criteria. If they produce ozone or hydrogen peroxide then they may pose safety concerns.

For this, the following parameters must be considered:

- Clean air delivery rate (CADR)
- Noise
- Energy efficiency
- Placement of the air cleaner
- Service and maintenance
- Generation of pollutants (the possible negative effect of the air cleaner on the indoor air quality, such as ozone generation).
- Operation
- Service

General information

The air purifier must meet all regulatory requirements and be approved from an electrical safety point of view by the European Union or national authorities.

Data which demonstrates the safe and effective performance of the unit must be obtained from third party testing and presented by a third-party certification body. An example of a certification program that operated by Eurovent Certita Certification [1] and [2].

Clean air delivery rate (CADR)

"Clean air delivery rate- CADR" is the air flow, free of specific pollutant, which is supplied to the room by the cleaner. It can be estimated as a product of air flow through the unit and the removal efficiency of the unit for a specific pollutant (usually particulate matter). Regarding the removal efficiency of the cleaner, the most critical size for particulate matter is 0.3–0.5 µm.

Particle removal efficiency is calculated by subtracting the measured average ratio of downstream-to-upstream particle concentrations from unity.

CADR can be expressed for any other pollutant as well. Eurovent Certita Certification has identified [2] the following pollutants: particles of 0.3 µm to 0.5 µm, particles of 1.0 µm to 2.0 µm, particles of 3.0 µm to 5.0 µm size, Acetone, Acetaldehyde, Heptane, Toluene, Formaldehyde, *Staphylococcus epidermidis, Aspergillus niger* and *Fel-D1* cat allergen.

The effect of CADR for the unit(s) placed in the room on the overall level of pollutants present in the room depends on the size and ventilation rate (outdoor air) of the room.

To achieve a meaningful additional reduction of viral particles in the indoor air CADR (measured for particle size of 0.3–0.5 µm) should be two times greater than the outdoor air flow by the ventilation system [2] in rooms with a ventilation rate more than 1 ACH. This CADR reduces the concentration of a pollutant by 70%. In rooms with a lower ventilation rate (lower than 1 ACH) the CADR must be at least 2 ACH.

For example: Clean air delivery rate (CADR)

If the room air volume is 200 m^3 and the air change rate 3 ACH, the effective CADR must be 2 × 3 × 200 m^3/h = 1 200 m^3/h = 333 ℓ/s or more.

For residential use the Swedish Asthma and Allergy Association recommends CADR = 4 × (ventilation rate) [3] When the outdoor air ventilation rate is 0.5 ACH then CADR should be 4 × 0.5 ACH = 2 ACH.

In a bedroom with a floor area of 15 m^2 a room height of 2.7 m and design ventilation rate 0.5 ACH, the CADR should be 4 × 2.7 × 15 × 0.5 = 81 m^3/h=22.5 ℓ/s.

The combined effect of the ventilation and air cleaner on the concentration of pollutants generated indoors is the sum of the CADR and the ventilation rate.

Noise

Noise generated by the cleaner is usually expressed in sound power generated by the device. The sound pressure level in the room depends on the sound power and acoustic properties of the room.

The sound power of the cleaning unit running on the effective speed shall not cause excessive sound pressure levels in the room. If the sound pressure level is too high, the user may switch the cleaner off or turn it to a lower, less effective, speed, with the consequence that pollutant levels in the space will increase. Sound pressure levels in a typical room (absorption app 10 m^2-sab) are a few (1-3) decibels lower than the sound power level of the unit. The sound pressure level should not exceed nationally regulated levels, and should typically be 30dB(A) in bedrooms, 35 dB(A) in living rooms, 35 dB(A) in single offices, 40 dB(A) in landscape offices and 35 dB(A) in classrooms (Cat II in CEN 16798-1 [4]).

The sound pressure values must be tested and stated for the effective CADR of the unit, so that users know the anticipated acoustic performance of the unit at the intended CADR.

Energy efficiency

The energy efficiency of the air cleaner must be reported, based on the relevant standard test, and is defined as air flow rate per unit of electrical power, ℓ/s per W or m^3/h per W. Classes used by Eurovent Certita Certification range from A class > 13 $m^3/h/W$ to class E < 2 $m^3/h/W$.

Placement of the air cleaner

In the performance test, the air cleaner is usually placed in the middle of the test chamber. A mixing fan is used to achieve a uniform concentration in the test room. If the cleaner is placed in the room so that the air flow through it is obstructed or so that there is a short circuit from supply to return in test conditions, its cleaning effectiveness in practical applications may be reduced compared to the test result.

To avoid this the cleaner must be placed in a room so that the furniture or walls do not disturb the intended air flow pattern.

Generation of pollutants (by-product)

If the cleaner is using electricity in the cleaning process, for example for photocatalysis, electrostatic filters, UV-A or UV-C lamps and plasma/ionization units there should also be a test report on the ozone levels. Ozone levels must be below 0.05 ppm in the test room where the CADR of the air cleaner is measured. The measured results of potentially harmful byproducts should be made available on request. It should

be noted that sensitive people (e.g. those who are asthmatic or have allergies) may have symptoms even at lower O_3-concentrations than 0.05 ppm. Ozone is also a driver of other indoor chemical reactions and the products of this ozone-initiated chemistry are often a greater threat to human health than their precursors.

The ASHRAE's position document on air cleaning [5] concludes that any ozone emission that is non-trivial (beyond a trivial amount that any electrical device can emit) creates a risk. Consequently, devices that use the reactivity of ozone for the purpose of air cleaning should not be used in occupied spaces and devices that emit ozone as a by-product of their operation should be used with extreme caution if emissions are non-trivial, and at best be replaced by alternatives which do not produce ozone.

The US EPA concludes that currently available scientific evidence shows that, at concentrations that do not exceed public health standards, ozone is generally ineffective in controlling indoor air pollution [6].

The UK Scientific Advisory Committee for Emergencies review of air cleaning devices [7] concludes that application of air cleaning devices may be a useful strategy to reduce airborne transmission risks in poorly ventilated spaces. It also notes that air cleaning devices have limited benefit in spaces that are already adequately ventilated, and are not necessary for adequately ventilated buildings unless there are identified specific risks.

Operation

The cleaner shall be used at a fan speed which is appropriate for the room where it is located. Most air cleaners collect dust and other pollutants in the unit. The filter media or the collecting plates may become a source of odor and pollutants if not maintained or replaced according to the manufacturer's instructions. In any case, manufacturers' instructions shall be followed by the users and when cleaning the units or filters appropriate precautions shall be taken to protect those maintaining the unit.

Service and maintenance

Spare parts like filter units must be readily available and easily replaced. Operation and maintenance information should be available, including the instructions of the replacement period of components.

The used filter units of the air cleaner must be handled as hazardous waste, along with any protective clothing and breathing masks used by the maintenance personnel. ■

Acknowledgements

- Reviewed by REHVA TRC and REHVA Covid Guidance Group March 1 and 10, 2021
- Language checked by Hywel Davis, CIBSE

References

[1] https://www.eurovent-certification.com/en/third-party-certification/certification-programs/acl-air-cleaners.

[2] Technical certification rules for the mark Afnor, Certification identification no.: NF 536, approved 5th of August, 2020.

[3] Criteria for recommendation of Air Purifier, Astma and Allergy Förbundet, Sweden, 2020.

[4] EN 16798-1 Energy performance of buildings – Part 1: indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics. https://epb.center/documents/en-16798-1/.

[5] ASHRAE Position Document on Filtration and Air Cleaning, 2015.

[6] https://www.epa.gov/indoor-air-quality-iaq/ozone-generators-are-sold-air-cleaners.

[7] Scientific Advisory Committee on Emergencies Environment and Modelling Group (SAGE EMG) UK, Potential application of Air Cleaning devices and personal decontamination to manage transmission of COVID-19, November 2020 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/939173/S0867_EMG_Potential_application_of_air_cleaning_devices_and_personal_decontamination_to_manage_transmission_of_COVID-19.pdf.