AIVC Newsletter Special Issue COVID-19

Editorial

We hope you are keeping safe and healthy during this challenging period. The COVID-19 pandemic has an unprecedented impact on all of us, both personally and professionally. As researchers and practitioners we also have a role to play in developing solutions to provide healthy indoor spaces to reduce disease transmission, and in informing the public. Based on developing scientific knowledge it has become clear that, although close contact transmission is the dominant transmission route, long-range airborne transmission through small size infected aerosols plays an important role in spreading COVID-19 in indoor spaces. As a consequence, increasing outdoor air change rates and other technical measures to remove infected aerosols are necessary to reduce infection indoors.

The AIVC board decided in their last (online) meeting of September 2020 to start a project to collect, discuss and disseminate information about COVID-19 in relation to ventilation and airtightness. A working group was created to define and carry out the project, with the title 'Ventilation, airtightness and COVID-19'. The working group members are listed at the last page of this newsletter.

This newsletter is a first outcome of the project. It presents a number of questions and answers developed and reviewed by working group members. The collection of relevant questions and the development of clear answers in line with most recent scientific understanding is a continuing process, to which we also invite you, as a reader, to participate. Let us know if you have a question for the working group. This way we hope to expand the FAQ-section, also posted on the AIVC-website. Many other international organizations in the domain of HVAC, health care and disease prevention have developed information and guidance documents to support decision makers and the public about the COVID-19 pandemic. This newsletter therefore contains an overview of frequently asked questions in relation to COVID-19 and building ventilation, developed by a number of those organizations. The ventilation related guidelines by REHVA and ASHRAE will receive specific attention during the upcoming AIVC webinar, to be held on November 20th, 2020. This webinar is a second outcome of the project, with detailed information in this newsletter and on the **AIVC website**.
We wish you a pleasant reading and look forward to seeing you in our future events.

Arnold Janssens, chair of AIVC Working Group on COVID-19

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Contents

November 2020

20 November 2020 (16:00-17:30 CET) – AIVC Webinar – COVID-19 Ventilation related guidance by ASHRAE and REHVA

Ventilation is recognized as a major element in strategies for minimizing the risk of COVID infection. REHVA and ASHRAE have developed guidelines, insisting on existing evidence of long-range aerosol-based transmission and emphasizing the importance of ventilation.

The Air Infiltration and Ventilation Centre with support from ASHRAE and REHVA are organizing the webinar "COVID-19 Ventilation related guidance by ASHRAE and REHVA" to be held on Friday November 20th, 2020 at 16:00-17:30 (CET).

The webinar will present the COVID-19 related guidelines by REHVA and ASHRAE and will also have a closer look to the similarities and differences in both guidelines.

Presentations and Speakers

- Introduction, *Arnold Janssens, chair of AIVC WG COVID-19*
- REHVA guidance regarding ventilation, *Jarek. Kurnitski – chair of REHVA COVID-19 task force*
- ASHRAE guidance regarding ventilation, *William P. Bahnfleth, chair of ASHRAE's Epidemic task force*
- Similarities and differences between REHVA's & ASHRAE's guidance, *Valérie Leprince, member AIVC COVID-19 working group & ASHRAE's Epidemic task forces*

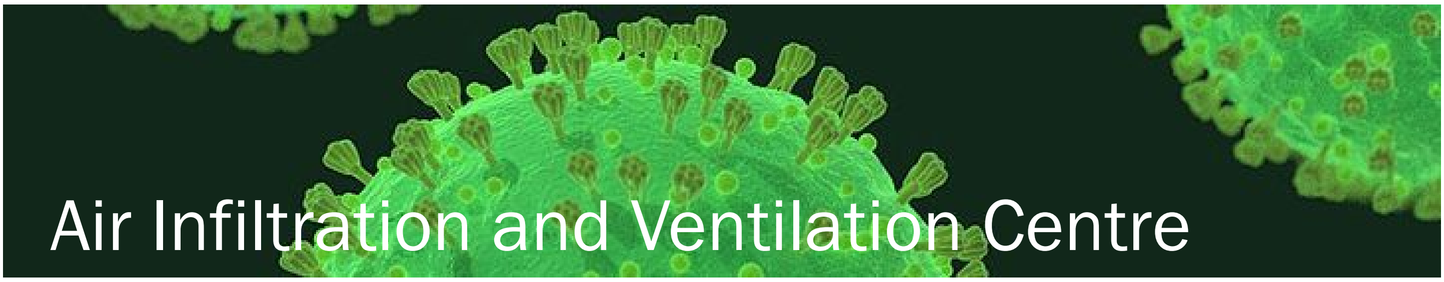
Participation to the webinar is **FREE** but requires you to **REGISTER** for the event. For further information please visit our website.

Call to readers

Do you have a question about COVID-19 and ventilation?

Let us know and the AIVC COVID-19 Working Group will try to provide an answer.

Email us at info@aivc.org



Air Infiltration and Ventilation Centre

AIVC's COVID-19 Working Group FAQs

Can a measured CO_2 concentration show a building is SARS-CoV-2 safe?

Benjamin Jones, University of Nottingham, Jelle Laverge, Ghent University & Pawel Wargocki, Technical University of Denmark

AAn indoor CO_2 concentration is commonly used as an indicator of the ventilation rate in indoor spaces, albeit with great uncertainty. Its concentration depends on the number, demographics, and activities of occupants, the outdoor air supply rate, mixing, inter-zonal airflow, the air renewal rate, and the outdoor concentration.

When using CO_2 as an indicator, a steady-state concentration must be achieved. Consequently, measurements should typically be made over at least 1 hour to ensure a representative reading. The placement, mixing of air within a space, and accuracy of sensors must be accounted for when analyzing measured data.

The rate at which people shed the virus depends, among other factors, on respiratory activity, such as speaking, singing, coughing, and sneezing, physical activity, and demographics. The dose is a function of occupant physical activity, airborne aerosols concentration, and exposure time.

A CO_2 concentration does not indicate with much certainty that the occupants of a building are safe from airborne exposure to the SARS-CoV-2 virus and is not recommended as a reliable proxy of the risk of airborne exposure to the virus. This is particularly true in spaces where there is filtration and UV-C radiation because they eliminate the virus but not the CO_2.

In some circumstances a CO_2 concentration can provide a crude indication that a building is not adequately ventilated and consequently occupants are likely to be at a higher risk of exposure to the virus. Limiting CO_2 concentrations should be determined based on the space and its use, and the outdoor concentration. Occupant activities, such as singing, loud speech, and exercise, increase the emission of aerosols containing the virus. In these circumstances, higher than normal ventilation rates are advised. However, as a rule-of-thumb, if the CO_2 concentration is >1400 ppm the building may be considered to be under ventilated.

There are circumstances where a CO_2 concentration cannot be used as a proxy for under ventilation. For example, in low occupancy or large volume spaces where there is much less certainty in the relationship between CO_2 concentration and the ventilation rate.

Finally, CO_2 should not be used when its source is not exclusively from people, such as combustion devices.

Can portable air cleaners prevent the spread of Covid-19 indoors?

Alireza Afshari, Aalborg University

Measures to reduce risk of exposure to the virus that causes COVID-19 from spreading indoors generally fall into three main categories: source control, ventilation control, and removal control. Removal by air cleaning can thus help to reduce the risk of exposure to the virus. There are several portable air cleaners on the market; for instance, portable HEPA (high efficiency particulate air) filters and germicidal ultraviolet light (GUV). HEPA filters have the ability to remove 99.97% of particulate matter, smog and microorganisms that have a size at 0.3 µm. The filtration efficiency increases for particle diameters both less than and greater than 0.3 µm. For instance, a HEPA H13 filter is capable of removing up to 99.95% of Maximum Penetration Size Particles (MPPS). According to EN-1822, the filters must be tested with the particle of maximum penetration size (MPPS - Most Penetrating Particle Size). The MPPS for each filter ranges from 0.12 µm to 0.25 µm (1). The size of the virus that causes COVID-19 is estimated to be between 0.12 µm and 0.16 µm and the minimum size of a respiratory particle that can contain SARS-CoV-2 is calculated to be approximately 4.7 µm. In addition, the minimum size of the particles can decrease due to the evaporation of water on the particle surfaces (2). Therefore, portable air cleaners equipped with HEPA filters can reduce the aerosol transmission risk for COVID-19. It should be recognized that such devices must have a clean air delivery rate (CADR) that is sufficient for the characteristics of the desired room.

GGUV, also known as UVGI uses ultraviolet light in the UV-C wavelength range (200 nm to 280 nm) to inactivate microorganisms. Most systems use low-pressure mercury lamps that produce a peak emission of approximately 254 nm. The virus that causes COVID-19 is susceptible to GUV, so if it is irradiated for a sufficiently long period of time, it becomes inactivated. There are three air disinfection applications on the market. One application is upper-room germicidal systems, the other is UVGI cleaners used in HVAC systems, and the third is portable air cleaners. The upper-room systems can reduce the amount of active virus in the air by an equivalent of 10 air changes per hour or more of outdoor air at a much lower energy cost (3). The other application is UVGI cleaners in HVAC systems that are designed to destroy/ inactivate viruses in the flowing air stream as they pass through the device. Portable air cleaners can incorporate UV-C lamps in their design in order to destroy and remove viruses trapped on air filter medium surfaces. According to SAGE_EMG, there is good evidence that GUV, using UV-C light, is likely to be a viable decontamination approach against SARS-CoV-2 for unoccupied rooms (4). There are several portable devices on the market that show good single-pass efficiency.

However, their effectiveness in a room is dependent on their flow rate relative to the room size; many devices have an insufficient airflow rate to be very effective in practice. Finally, it is important to mention that air cleaners cannot fully replace a ventilation system. Please visit the IEA EBC Annex 78 "Supplementing Ventilation with Gas-phase Air Cleaning, Implementation and Energy Implications website to know more.

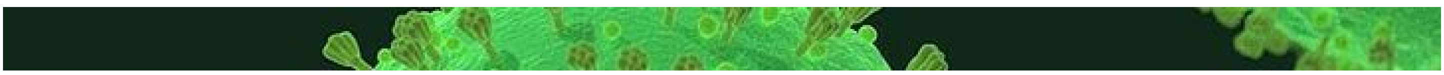
References

1. *EN 1822: High efficiency particulate air filters (HEPA and ULPA), parts 1-5*. Beuth Verlag GmbH, Berlin 1998/2001.

2. Byung Uk Lee. *Minimum Sizes of Respiratory Particles Carrying SARS-CoV-2 and the Possibility of Aerosol Generation*. Int. J. Environ. Res. Public Health 2020, 17, 6960

3. Riley R. L., Knight M., Middlebrook G. *Ultraviolet susceptibility of BCG and viru-lent tubercle bacilli*, Am Rev Respir Dis . 1976 Apr; 113(4):413-8.

4. SAGE – Environmental and Modelling Group. *Application of UV disinfection, vis-ible light, local air filtration and fumigation technologies to microbial control*. 31 July, 2020.



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Are Covid-19 recommendations of REHVA & ASHRAE similar?

Valérie Leprince, INIVE

REHVA and ASHRAE agree on their main recommendations, but there are some slight differences in the specifics.

Both REHVA and ASHRAE note that long-range aerosol-based transmission is possible and that ventilation plays an important role to limit the risk of transmission. They stress the need to increase ventilation flowrate (more air renewal) for more dilution and reduction of pollutants concentration. However, the specific ventilation rate to most effectively reduce the risk of transmission of airborne particulate matter is unknown.

Therefore, the questions below remain open and REHVA and ASHRAE have slightly different answers.

Various explanations can be found for those differences including:

• Typical ventilation systems in Europe and US are different. While Europe relies on outdoor air ventilation and air conditioning that is typically separated from hydronic heating, in the US all systems for air conditioning typically include heating and cooling and air recirculation with minimal minimal outdoor air intake.

• The impact of thermal conditions is considered to be more important for ASHRAE than for REHVA. It may be partly due to a better acceptation of adaptative comfort in Europe than in the US.

• Regarding filters, REHVA, recommending HEPA and ePM1 80% filters, has a more “safe-side” approach than ASHRAE who recommends MERV 13 filters but with higher flowrate.

According to REHVA & ASHRAE, how much should ventilation level be increased?

REHVA proposes to adopt the principle of ALARA (As Low as Reasonably Achievable) for the concentration of pollutants. REHVA and ASHRAE agree that mechanical ventilation rate should be set at its reasonable maximum, that DCV system should be overruled (by a setpoint at 400ppm for CO_2) and that rooms should be “flushed” before and after occupancy. REHVA recommends 800 ppm CO_2 (absolute value) as a proxy of good ventilation.

However, while ASHRAE warns against causing thermal stress, and thereby lowering resistance to infection, and estimate that other methods should be considered first when the energy/comfort/IAQ conditions warrant, REHVA recommends to supply as much outdoor air as reasonably possible and use openable windows much more than normal even if this causes thermal discomfort (for buildings without mechanical ventilation).

According to REHVA & ASHRAE how should recirculation be used?

ASHRAE recommends upgrading recirculation filters to MERV 13 and does not recommend switching off recirculation. When using MERV 13 filters, ASHRAE recommends maximizing flow through the filter to remove as many infected aerosols as possible. In general, ASHRAE notes that dilution, filtration and disinfection all act together and that in many circumstances filtration can be more effctive than increased ventilation.

REHVA recommends to close recirculation dampers even if they have air filters. If recirculation cannot be avoided, additional measures for return air filtering should be taken with the installation of HEPA filters or at least ePM1 80% filter (MERV 13 are to be compared to ePM1 50% filters).

For room level recirculation, ASHRAE does not have specific recommendations, while REHVA recommends either to switch off the system or run the fan constantly at low speed (to avoid the collection and release of contaminated particles). However, currently REHVA is updating fan coil recommendations in their version 4 guidance with the focus on sufficient outdoor air ventilation and warning for possible high velocity directed airflows.

According to REHVA & ASHRAE, are filters effective to filter or inactivate virus?

While ASHRAE suggests that MERV 13 filters are sufficient to catch infected aerosols, and estimates that high air change rates through moderately high-efficiency filters do help, REHVA implies that only HEPA filters can filter all virus particles effectively, however accepting ePM1 80% filter as a minimum improvement.

Ultraviolet Germicidal Irradiation (UVGI) technologies are recommended by ASHRAE in all kinds of buildings, while REHVA only states that “UVGI” and Germicidal Ultraviolet “GUV” may be used.

According to REHVA & ASHRAE, how should portable air-cleaning devices be used?

Both ASHRAE and REHVA recommend using portable air-cleaning systems, but REHVA implies it is mostly effective if located in the breathing zone.

REHVA only recommends air cleaners with HEPA filters efficiency and says that UVGI may be installed in return air ducts in systems with recirculation or in rooms provided that they are correctly sized, installed and maintained.

ASHRAE estimates that UVGI upper room systems are more effective than in-duct in terms of CADR (Clean Air Delivery Rate) but are only suitable in some spaces.

According to REHVA & ASHRAE, can heat-recovery sections be used?

ASHRAE provides extensive information to evaluate on-site the risk of unwanted recirculated air in heat recovery sections, and according to the fan arrangement may recommend to by-pass the heat recovery.

REHVA does not provide a method to ensure that there is a 100% air separation but recommends to by-pass heat recovery or to adjust the pressure if critical leaks are detected for rotary air to air heat exchanger.

References

1. REHVA. *REHVA COVID-19 guidance document How to operate HVAC and other building service systems to prevent the spread of the coronavirus (SARS-CoV-2) disease (COVID-19) in workplaces.* 3 August, 2020.

2. ASHRAE. *COVID-19 response resources from ASHRAE and others. ASHRAE COVID 19 website*. Retrieved November 2020.

3. Mingyue Guo, Peng Xu,Tong Xiao, Ruikai He, Mingkun Dai, Shelly L. Miller. *Review and comparison of HVAC operation guidelines in different countries during the COVID-19 pandemic*. Building and Environment (2020), doi: https://doi.org/10.1016/j.buildenv.2020.107368.

Selection of FAQs related to COVID-19 - As developed by IEQ-GA, ASHRAE, REHVA, WHO & SAGE-EMG

The Indoor Environmental Quality – Global Alliance (IEQ-GA) and in particular its members involved in the IEQ-GA Task Force on COVID-19, developed a series of ***Questions & Answers (Q&A)*** intended to address concerns about COVID-19. The AIVC is member of the IEQ-GA.

1. Can opening windows, as WHO suggests in some cases, give the same result of a mechanical ventilation system with respect to COVID-19 pandemic?
2. How can I best manage my HVAC system to reduce the risk of the spread of COVID-19?
3. How can I best manage an all-air systems (heating and air-conditioning) serving a large office building to reduce the risk of the spread of COVID-19?
4. How can I best manage all-air systems (heating and air-conditioning) serving a few spaces under the same ownership to reduce the risk of the spread of COVID-19?
5. How can I best manage primary air systems to reduce the risk of the spread of COVID-19?

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) has an ***Frequently Asked Questions (FAQ)*** section on its website. An example of interesting questions is given below.

1. My home has wall-mounted ductless mini-split AC units. I know their filtration is minimal. Can I improve filtration of small and potentially infectious airborne particles?
2. Is it safe to continue use my ERV or HRV to provide ventilation in my single-family home?
3. What is the size of the SARS-COV-2 virus, and can it be captured by ventilation filters?
4. Is it OK to have a blower door test done on my house and if so, should I take special precautions?
5. What is the proper amount of outside air to spaces where infections exist or are known to have occurred?

The Federation of European Heating, Ventilation and Air Conditioning associations (REHVA), has received several questions and requests for clarifications from industry, academia and government experts, related to the REHVA Guidance document. ***REHVA's COVID-19 FAQs webpage*** provides answers.

1. What are the recommended rates of air exchange for different types of workplaces such as offices, shops, factories and so on.
2. How does this relate to level of occupancy? Presumably you need faster turnover in crowded places?
3. Is there a recommended maximum CO_2 level?
4. Is it safe to recirculate warm air after filtering?
5. Can filters actually remove viral particles?

The World Health Organization (WHO) provides answers to questions on COVID-19 related health topics. i.e. ***Coronavirus disease (COVID-19): Ventilation and air conditioning***, and ***Coronavirus disease (COVID-19): Ventilation and air conditioning in public spaces and buildings***.

1. What is WHO doing to address ventilation in the context of COVID-19?
2. Can I use air conditioning in the context of COVID-19?
3. Can fans be used safely in indoor spaces?
4. What steps can be undertaken to improve the ventilation in indoor public spaces and buildings?
5. How can ventilation reduce the risk of contracting COVID-19 in airplanes?

The Scientific Advisory Group for Emergencies (SAGE) provides scientific and technical advice to support the UK government decision makers during emergencies. The Environmental and Modelling Group (EMG) has produced a document entitled "***Role of Ventilation in Controlling SARS-CoV-2 Transmission***".

1. How is the risk of airborne transmission impacted by the level of ventilation?
2. To what degree does the density of people within a setting influence airborne transmission risk and consequently ventilation requirements?
3. To what degree does the density of people within a setting influence airborne transmission risk and consequently ventilation requirements?
4. How can CO_2 sensors be used to understand ventilation effectiveness?
5. What steps could be taken to improve ventilation and what would be needed to achieve this?

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