AIVC Newsletter Special Issue COVID-19

Editorial

This is the 3rd special issue of the AIVC newsletter, with the aim to disseminate information about COVID-19 in relation to ventilation and airtightness. As in previous newsletters a new set of question and answers is provided to address issues in relation to COVID-19 and building ventilation in line with most recent scientific understanding. More elaborate answers are available on the FAQ-section of the AIVC-website, where all FAQ's in relation to COVID-19 are listed. The newsletter also contains an article by Jinjun Ye et al. giving an overview of general practice guidelines of HVAC system use in China during the pandemic of COVID-19.

This newsletter is one of the outcomes of the AIVC project 'Ventilation, airtightness and COVID-19'. Since its launch almost one year ago, the project's working group has produced three special issues of the AIVC newsletter, a list of Frequently Asked Questions, and two webinars, of which the slides and recordings are available on the AIVC website. The working group members are listed at the last page of this newsletter.

Since the beginning of the year, COVID-19 vaccination campaigns have picked up in many countries and infection rates have been falling. At the time of writing lockdown measures are gradually being lifted in many countries, and indoor spaces are reopened for business and leisure, often under the condition that safety measures are in place to prevent infections. Some countries have established national ventilation plans to improve IAQ in indoor spaces, to help sectors reopen their buildings in a safe way, and have built up experience with implementing them in practice by organizing a number of test events. Also the World Health Organization has published a roadmap on how to improve ventilation in indoor health care, non-residential and residential spaces. Both in national ventilation plans and the WHO roadmap the first step is to assess whether the effective ventilation rates by mechanical and natural ventilation meets proposed minimum requirements. Since the reliable estimation of ventilation rates touches upon the experience of AIVC, the WG has been developing feedback for WHO to further improve the roadmap. We hope to give you more news about all this in the future.

We wish you a pleasant reading and look forward to seeing you in our future events.

Arnold Janssens, AIVC COVID-19 Working Group chair

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July 2021

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

AIVC's COVID-19 Working Group FAQs

What is the impact of a poor ductwork airtightness on the SARS-CoV-2 infection risk?

Valérie Leprince, INIVE

1) Ductwork leakage, by decreasing ventilation flowrates at air terminals, increases contamination risk. When ductworks are leaky, and the fan does not fully compensate for leakages, part of the flow is not extracted (resp. supplied) from (resp. to) the occupied zone. As a consequence, the actual air renewal of the occupied zone with uncontaminated air is lower than foreseen. Therefore, if an infected person is present in the zone, the concentration of infectious aerosols in the zone may be higher than expected.

2) Ductwork leakage may induce transfer of infectious aerosols between zones. Ductwork leakage may jeopardize the designed pressure balance between zones. As ductwork leakage repartition is impossible to assess, it makes it difficult to predict the exact supply and extract flowrate in a zone and thus the relative pressure between zones. This may induce unexpected air flowrate (and transfer of infectious aerosols) between zones. (see also FAQ 'Does transport of air from one room to another room play a role in relation to COVID-19?').

3) Ductwork leakage may induce recirculation of infectious aerosols. In some cases, the exhaust ductwork (which is the part of the extract ductwork that is downstream the fan and then overpressurised) is located inside the conditioned space, its leakage may induce the diffusion of infected aerosol in the conditioned space. The potential impact of ductwork leakage with respect to the three phenomena discussed above increases when the ductwork airtightness class is poorer, the operational pressure in the ducts is larger, and the size of the ductwork is bigger. Improving ductwork airtightness hence helps to limit airborne transmission of SARS-CoV-2.

For more information on ductwork airtightness, see VIP 40: Ductwork airtightness - A review.

What does SARS-CoV-2 teach us about building ventilation? Why should we care about it when there is a vaccine?

Valérie Leprince, INIVE

This pandemic has pointed out the importance of aerosol transmission in the propagation of diseases and more specifically respiratory diseases (such as the flue). Even if the vaccine stops the COVID-19 pandemic, seasonal diseases (flue, colds, bronchiolitis, etc.) will remain and it will still be important to limit their propagation indoors as their direct and indirect costs are huge [1].

A well-performing ventilation system reduces the concentration of infected aerosol in the air and thus the risk of becoming contaminated by breathing infected aerosol [2, 3].

This stresses the need to install well-designed, well-commissioned and well-maintained ventilation systems in buildings, all the more in spaces where social distances are respected and therefore where aerosol transmission is the main source of infection (ex. non-residential building).

It highlights also the need to raise awareness among public authorities, building professionals, building owners and users on the crucial subject of building ventilation.

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[3] https://www.ecdc.europa.eu/en/publications-data/heating-ventilation-air-conditioning-systems-covid-19

What air change rate one can expect when a window is open in a room with doors closed?

Willem de Gids, VentGuide

The air change rate depends on the size of the window relative to the room volume, the opening mechanism and position, the window height, the indoor temperature, and the weather conditions such as outside temperature, local wind speed and direction. It also depends on other possible window openings in the room in adjacent or opposing walls, and on leakages in the wall and ceiling constructions, for instance cracks around a closed door.

Generally, the air change rate as a result of window airing is normally higher than provided by the standard ventilation system for IAQ purposes. The windows are normally sized for airing to achieve large flowrates for instance to get rid of heat during periods of too high temperatures inside, or to quickly get rid of incidental smells.

Assuming single sided ventilation the situation is always a result of the combination of the driving forces temperature (indoor-outdoor difference), wind speed and turbulence.

In case only temperature differences play a role the air velocity in the window opening can be calculated. But also wind and turbulence play a role in flow through open windows. It is a rather complex phenomenon. There are several publications available in which one can find a method to estimate the flow through open windows.

References

[1] Investigation of the consequences of opening one window on the internal climate of a room. J.C. Phaff and W.F. de Gids. AIVC AIR November 1982

[2] A Guide to Energy Efficient Ventilation AIVC 1996

[3] CIBSE Applications Manual 10 Natural Ventilation in Non-Domestic Buildings, CIBSE 2005

How to use the openable windows to provide sufficient ventilation to limit SARS-CoV-2 transmission in class rooms?

Willem de Gids, VentGuide

Opening windows almost always reduces the risk of contamination with SARS-CoV-2. But it is important to be aware of low outdoor air temperatures that could affect the comfort of occupants and exacerbate related health problems.

However, the quantity of ventilation needed depends on the amount and nature of the SARS-CoV-2 aerosols. If the emission characteristics of SARS-CoV-2 and the dose-response curve was known, then it would be possible to calculate the ventilation rate needed to prevent occupants' exposures exceeding a predefined safe dose. At the time of writing there is insufficient scientific knowledge to define this rate.

It is advisable to open windows in one façade and keep the internal doors closed to minimise the risk of spreading SARS-CoV-2 to connected spaces, such as corridors or hallways. An exception should be made for classrooms where openable windows are located in two opposite facades. Then, windows can be opened in both facades with internal doors closed.

Should I close my bathroom window due to SARS-COV-2?

Willem de Gids, VentGuide

The decision to open or close a bathroom window depends on other aspects such as: 1) Is it the only provision to ventilate the bathroom?, 2) Is there also an extraction mechanically or naturally?

Suppose the window is the only provision to ventilate. First, close the bathroom door. Assuming that the outside air coming in through the window is free of SARS-CoV-2, the opening the window to its' maximum is recommended. Then, the dilution of any contaminant is at the highest level. The concentration will hence be at the lowest level.

When the person in the bathroom is infected with the corona virus, there is a risk of spreading the virus to the rest of the dwelling when there is an over pressure in the bathroom due to wind pressure. Nevertheless the concentration is as low as possible in when the window is wide open.

Suppose the bathroom has a passive duct or mechanical extraction. First, close the bathroom door. The air extracted through the passive duct or the mechanical system determines the pressure between bathroom and the adjacent part of the dwelling. It is always better to strive for an under pressure to prevent the spreading of moisture. The same is valid in case of SARS-CoV-2. The dilution rate determines the concentration of the virus in the air and hence it is advised to open the window as wide as possible.

Is there good evidence that germicidal UV (GUV) could be beneficial for decontamination of infectious aerosols in occupied environments?

Alireza Afshari, Aalborg University

Yes, Germicidal Ultraviolet (GUV*) irradiation is an established technology that has been use in many years to disinfect air, water, and surfaces. Air disinfection is carried out via several methods, for instance irradiating the upper-room air. There is good evidence that upper-room GUV irradiation can lower the concentration of airborne organisms in the lower part of the room and thereby controlling the spread of airborne infection among occupants. GUV poses a health hazard to the eyes and skin if the lamps are improperly used or installed. Therefore, to be safe and effective this technology requires design and installation from a suitable professional.

*Germicidal Ultraviolet (GUV) irradiation, also known as Ultraviolet Germicidal Irradiation (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 (see also FAQ 'Can portable air cleaners prevent the spread of COVID-19 indoors?').

Can we use ventilation with outdoor air during high pollution events outdoors?

Steven Emmerich, NIST

In general, you should follow the guidance of local public health officials when high outdoor pollution events (such as wildfire smoke) occur in your building's location. It is anticipated that persons who are either susceptible to or affected by COVID-19 may have health conditions that also make them more vulnerable to high outdoor pollution. To reduce your exposure to high outdoor pollution, you should stay indoors and take steps to clean the indoor air such as improving air filtration or setting up a clean air room. While increasing ventilation rates is good for reducing COVID-19 risk, this action is not recommended during high pollution events. However, a decision to turn off ventilation entirely can only be made after considering the details of your situation such as how severe the outdoor pollution is, whether building occupants have compromising health conditions, whether the filtration in the outdoor air path of the ventilation system can be upgraded, and whether turning off the ventilation will compromise designed building pressurization, which would allow additional outdoor pollution to enter via leaks in the building envelope.

Fortunately, the same filtration options, such as portable air cleaners with HEPA filters or MERV 13 (or equivalent) filters in HVAC systems, that will reduce risk of COVID-19 will also typically be effective at reducing indoor particle concentrations from high outdoor pollution. However, if the outdoor air pollution is not particulate but gaseous, typical portable air cleaners and HVAC filters will not help. If there are known or suspected COVID-19 infected persons in your building, you should create a separate clean air room with a portable air cleaner for them.

HVAC system use in China during the pandemic of COVID-19

Jinjun Ye, Chen Lin, Jing Liu, Zhengtao Ai, Guoqiang Zhang-Department of Building Environment and Energy, Hunan University, China

This document summarizes the general practice guidelines of HVAC system use in China during the pandemic of COVID-19.

A. Non-medical buildings

The first thing is to make sure that the outdoor air intake of a HVAC system is clean and its exhaust air does not flow to other occupied areas. The system should be switched on in advance to preheat/precool the building; if the comfort requirement can be met through only the fresh air system, other air conditioners should be switched off. A per capita fresh air volume must be not less than 30 m^3/h. For office buildings with all-air systems, the indoor CO_2 and PM2.5 concentrations should be monitored, and when the CO_2 concentration is higher than 600 ppm, the number of occupants should be decreased and the fresh air should be increased. The room without a fresh air system or without windows for natural ventilation should not be used. One should try to avoid the use of return air; if it must be used, the fresh air ratio should be as large as possible. However, a variable air volume system with the return air being taken from a shared ceiling area by different rooms must not be used. A single fan-coil system serving different rooms, which may cause air across different rooms, must not be used. For heat exchangers, only those that do not cause cross-contamination can be used. The ventilation system should continue to operate for a period after being occupied. If there is a suspected or confirmed case, the affected area (including HVAC systems) must be closed and disinfected immediately. For different types of spaces, there are the following additional recommendations:

• For office buildings, the office rooms without fresh air system or with insufficient fresh air supply should be ventilated regularly by additional methods, such as open windows, and each ventilation period should be more than 20 minutes. The staff canteens should ensure continuous operation of the air supply and exhaust system during serving periods, which should continue to operate for one hour after serving periods. For canteens without fresh air system and exhaust system, natural ventilation should always be used during serving periods and should be performed for more than 30 minutes before and after serving periods. The meeting rooms should be ventilated for not less than 30 minutes before and after use.

• The ventilation system of underground garages should be switched on 1-2 hours before working time. During the commuting periods, measures such as the smoke exhaust system should be activated to increase the exhaust air volume;

• Classrooms and canteens in schools should be ventilated for at least three times a day and each ventilation period should be more than 30 minutes.

• The hotels used as temporary isolation points, where one room is occupied by one person, should use the split air conditioners for thermal comfort. The air change rate should not be less than 6 h^{-1}. The exhaust air volume should be greater than the supply air volume to keep a room at a negative air pressure state.

• It is recommended not to use elevators. Otherwise, the ventilation must be adequate and disinfection should be intensified. The exhaust air volume of elevator cars and elevator shafts must be increased to maintain a negative air pressure inside;

• The exhaust air system in toilets and pantries must be kept running continuously throughout a day.

B. Hospitals

In the registration hall, waiting rooms and infusion rooms, the fan-coil units, split-type air conditioners, the indoor parts of the multi-split systems, and all-air systems that do not supply 100% outdoor air should be switched off. Independent fresh air system and exhaust system should be on and windows should be opened. The fresh air and exhaust air systems should be switched on two hours before occupation and switched off two hours after occupation. In consultation offices, checking rooms and general wards, all-air systems that do not supply 100% outdoor air should be switched off. The fresh air system and exhaust system should run continuously for 24 hours. Open the windows as much as possible. In consultation offices and checking rooms, an additional movable air cleaner with a high-efficiency filter should be used. In general wards, if possible, an additional movable air cleaner with a high-efficiency filter should be used or a low-resistance medium-efficiency filter should be installed in the return air ducts.

In isolation wards, one-direction all fresh air systems shall be used. The supply air should be treated by a three-level filtration system that includes simultaneously primary-, medium- and high-efficiency filters, and the exhaust air should be treated by a high-efficiency filter. The exhaust air filter should be installed on the room side. Airflow distribution should cover all areas to ensure a rapid discharge of polluted air. The pressure difference between an isolation ward and its adjacent rooms should be maintained at least 5 Pa. Several air cleaners with sterilization and disinfection functions should be used in each isolation ward. Except that, the exhaust air in toilets and restrooms should have an air change rate of not less than 12 h^{-1}, and shall be discharged after high-efficiency filtration. The condensed water of the air conditioners in the contaminated areas should be collected centrally and discharged into the hospital's sewage drainage system for a further treatment.

The cleaning and disinfection of the HVAC systems should be carried out regularly. Use disposable materials and equipment whenever possible, and the medical waste should be disinfected in time. The places that occupants contact frequently such as banisters, floors and elevator buttons should be disinfected regularly.

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Air Infiltration and Ventilation Centre

List of previously published FAQ related to COVID-19

- *Does transport of air from one room to another room play a role in relation to COVID-19?*
- *How long should a room be ventilated after occupation to reduce the concentration of infectious aerosols?*
- *Is ventilation the same as air movement in relation to COVID-19?*
- *Can building's ventilation substitute mask wearing and social distancing while preventing COVID-19 transmission?*
- *How much ventilation is needed to limit COVID-19 aerosol-based transmission?*
- *Can air infiltration provide sufficient air supply with respect to COVID-19?*
- *Can portable air cleaners prevent the spread of COVID-19 indoors?*
- *Can a measured CO_2 concentration show a building is SARS-CoV-2 safe?*
- *Are COVID-19 recommendations of REHVA and ASHRAE similar?*

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