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Fachbereich AKTUELL

FBVW-502

SARS-CoV-2: recommendations for ventilation at indoor workplaces

Indoor climate Subcommittee
Last amended: 03 December 2021; valid as of: 14 September 2020

Introduction

Regular ventilation has the effect of replacing indoor air with fresh outdoor air. At the same time, used air, contaminants from materials (such as furniture and floor coverings), particles and biological substances (such as pathogens) are transported outdoors, as a result of which good indoor air quality is assured. In accordance with the German Ordinance on workplaces (ArbStättV) and the supporting ASR A3.6 Technical Rule for workplaces, Ventilation [1]], the breathing air in enclosed indoor working areas must be conducive to good health. Sufficient air exchange is particularly important during an epidemic, to reduce the risk of infection.

This Fachbereich AKTUELL supplements and supports the SARS-CoV-2 Occupational Safety Rule issued by the German Federal Ministry of Labour and Social Affairs (BMAS) [2]. The ventilation recommendations made in this document apply only for the duration of the SARS-CoV-2 epidemic. The focus lies upon indoor workplaces where the indoor climate does not have to be influenced for technical reasons (as for example in the food industry).

Contents

1 Airborne transmission routes

Airborne transmission of SARS-CoV-2 occurs through inhalation of droplets and aerosols produced during breathing, coughing, speaking and sneezing [3]. Droplets are > 5 µm in size; aerosols are ultrafine airborne liquid particles and droplet nuclei < 5 µm in diameter. The distinction between the two forms is fluid.

Owing to their dimensions, droplets fall to the ground more quickly. Aerosols remain in the air longer and can therefore spread to all parts of closed rooms. For this reason, the likelihood of exposure to infectious droplets and aerosols is greater within a radius of 1 to 2 meters from an infected person, and maintaining a minimum distance of 1.5 meters from other persons is therefore important. Where persons are present for longer periods in poorly ventilated or unventilated indoor spaces, the distribution and accumulation of contaminated aerosols throughout the indoor air also increases the probability of transmission over distances greater than 2 m. This hazard can be reduced by adequate ventilation of the rooms with outside air (dilution effect).

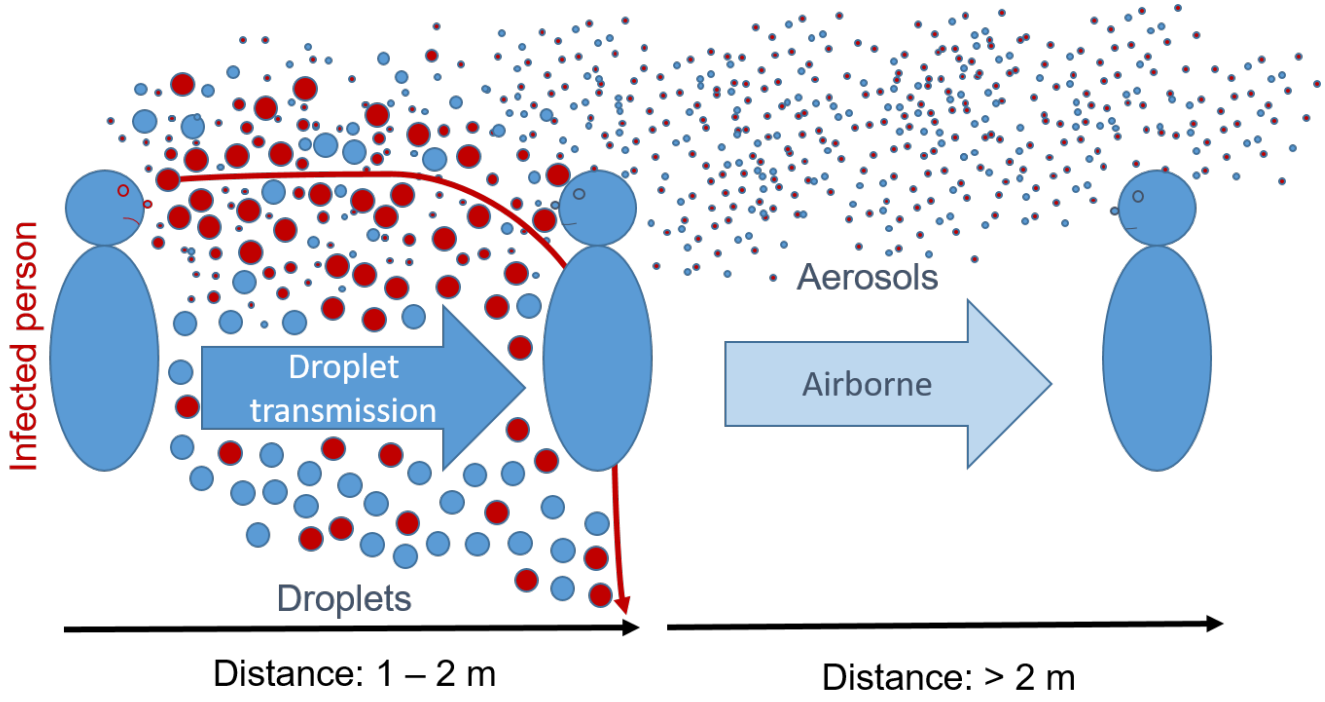

Figure 1 – Airborne transmission routes of SARS-CoV-2 by droplets at a distance of 1 to 2 meters and by aerosols at a distance of > 2 meters.

2 Ventilation

A distinction is drawn between natural and mechanical ventilation.

2.1 Natural ventilation

Natural ventilation is generally achieved by windows. Rapid air change through wide-open windows and ideally also wide-open doors are the most effective form of natural ventilation. Bursts lasting a few minutes are usually sufficient. Ventilation through tilted windows is less effective, but can be useful as a supplement for intermittent ventilation bursts to prevent an excessively rapid strong rise in virus concentrations [4]. An important aspect to consider is that the effectiveness of natural ventilation depends on the weather conditions, such as the wind direction and the temperature difference between the indoor and outdoor air. The dimensions of the open window areas and the room geometries also influence the effectiveness of natural ventilation; the corresponding limits of natural ventilation are described in ASR A3.6, Ventilation. For the duration of the SARS-CoV-2 epidemic, the CO_2 concentration can be used as a reference dimension for determining the ideal ventilation strategy for reducing aerosol concentrations. The CO_2 value does not however provide a clear indication of the actual concentration of aerosols contaminated with the virus.

ASR A3.6 recommends ventilation intervals of one hour for offices and similar rooms, and 20 minutes for conference and seminar rooms. The air quality can be monitored by measurement of the CO_2 concentration, for example with a CO_2 traffic light indicator. ASR A3.6 states that a CO_2 concentration of up to 1,000 ppm is acceptable. During an epidemic, the concentration should be kept below this level if at all possible. This entails more intensive and frequent ventilation.

Further information can be found in the Fachbereich AKTUELL on SARS-CoV-2 concerning the use of CO_2 measurement to evaluate ventilation measures [5].

Recommendations

- Regular intermittent ventilation bursts over the entire window area for 3 minutes in winter, 5 minutes in spring/autumn and approx. 10 minutes in summer.
- Thoroughly ventilate rooms used by several people, such as break rooms, stand-by rooms and canteens, and in particular conference and seminar rooms, before and after use.
- Adjust ventilation intervals according to the number of people in the room, e. g. every 20 minutes for offices [6].
- A CO_2 traffic light indicator can be used to measure the CO_2 concentration in the room as an aid to checking the air quality. Alternatively, the CO_2 concentration and suitable ventilation intervals can be calculated, for example by means of the DGUV's app “CO_2-Timer” [7] or the BGN ventilation calculator [8].

2.2 Mechanical ventilation

Mechanical ventilation is the use of a central or local HVAC system to route filtered fresh air from outdoors continuously into the indoor area. When air conditioning systems are used, the air can be heated, cooled, humidified and/or dehumidified at the same time. In contrast to natural ventilation, correctly adjusted HVAC systems ensure a continuous and adequate exchange of air, whatever the weather conditions.

The risk of a properly adjusted, operated and maintained HVAC system transmitting SARS-CoV-2 is considered low [2] [9]. HVAC systems should not therefore be switched off; instead, the supply of outdoor air through the system should be increased, and operation of such systems in recirculation mode avoided completely or reduced as far as possible. An adequate supply of outdoor air is the only means of reducing the concentration of aerosols contaminated with the virus. Where HVAC systems do not draw solely upon fresh outdoor air for the air supply and do not discharge the entire exhaust air outdoors, but instead partial recirculate the indoor air, aerosols contaminated with the virus are largely returned to the room. If recirculation of the air cannot be avoided, higher filtration levels should be used if possible, e. g. class ePM1 80% (formerly F9) instead of class ePM1 50% (formerly F7). Where technically possible, class H13 or H14 HEPA filters may also be used. The resulting higher filter resistance causes the flow rate to drop, however. Before a system is upgraded with H13 or H14 filters, a specialist company should therefore check whether this solution is in fact advantageous from a technical perspective.

Recommendations [6] [9]

- Ensure an adequate supply of outdoor air. Increase if necessary and avoid recirculation mode.
- Operate the HVAC system at rated capacity for at least two hours before and after the building is used.
- Do not switch off the ventilation when the building is not in use, e. g. at night or weekends; instead, operate it at reduced capacity.
- On systems with CO_2-based control, set the desired value to 400 ppm. This causes the system to be operated continuously at its rated capacity.
- Run the ventilation in sanitary rooms continuously.
- The operating points (heating, cooling, humidifying and dehumidifying) of air-conditioning systems do not need to be changed.
- Check heat exchangers for possible leaks.
- Observe the normal intervals for maintenance and inspection (manufacturer's information, VDI 6022 [10]). Additional cleaning of ventilation ducts is not necessary.
- Outdoor air filters need be replaced only as part of scheduled maintenance.
- Where recirculation mode cannot be avoided, higher filtration levels should be used if possible, e. g. class ePM1 80% (formerly F9) instead of PM1 50% (formerly F7); where technically possible, class H13 or H14 HEPA filters can also be used. The increased pressure drop through these high-performance filters must be taken into account.
- Ensure protection of the maintenance personnel when the filters are changed.

3 Local and mobile air recirculation equipment

Mobile and local air recirculation equipment includes air conditioners (e. g. split air conditioners), fan heaters and fans (e. g. floor-standing fans). Air conditioners and fan heaters draw in the room air and return it to the room after treatment. Such air recirculation equipment is not generally equipped with filters capable of effectively filtering out aerosols that may be contaminated with viruses [6]. Fans generate a flow of air for cooling, particular in summer. Mobile and local air recirculation units do not constitute primary ventilation equipment [2].

Air recirculation equipment does not bring about an exchange of the indoor air with the outdoor air, but merely accelerates even distribution of the air in the room. In the absence of air recirculation equipment, air movement still takes place owing to the heat emitted by persons and electrical appliances present in the room and by the movement of persons, which cause the air in the room to be thoroughly mixed within a short space of time. Air recirculation equipment merely speeds up this process.

Recommendations

- Ensure an adequate supply of fresh air from outdoors.
- Use air recirculation equipment such as air conditioners, fan heaters or fans only in rooms occupied by a single person [2] [4].
- Should air recirculation equipment nevertheless be used in rooms occupied by more than one person, a risk assessment must be performed of each case. Particular care must be taken here to ensure that air does not flow directly from one person to another, in order to avoid an increased risk of droplets or aerosols contaminated with the virus being transferred [11].

4 Air Purification

Air purifiers are designed to remove particulate matter, gaseous compounds and microbial contaminants from the air, thereby enhancing the air quality [12]. A distinction can be drawn between filtration and forms of air treatment such as those employing ozone, cold plasma, electrostatic precipitation, ionization or UV-C radiation.

Air purifiers are generally used as local mobile air recirculation equipment in indoor areas. However, as already described in Chapter 3, their drawback is that the recirculation mode of their operation does not transport any outdoor air into the indoor area, but instead distributes the existing air evenly throughout the room. Air purification is a less effective means of reducing the viral load than the direct supply of fresh outdoor air. Air purification by way of filtration and air treatment with UV-C radiation is also used in HVAC systems.

Air purifiers employing filtration must be equipped with high-quality filters, e. g. ePM1 50% (previously F7) or ePM1 80% (previously F9), or even better, with a HEPA filter (H13 or H14) [9]. An air treatment process utilising UV C radiation can be a useful supplement to filtration, provided that the device-specific operating parameters (such as the radiation dose) are known. In this case, care must be taken to ensure that the irradiation is of adequate duration, for example. The UV-C radiation must also not present a hazard to the workers.

The effectiveness of filtration in removing particles from the air has already been proven. Aerosols that may be contaminated with viruses are thus also removed.

Devices that employ different air purification techniques (UV-C radiation, ionisation, plasma filters etc.) reduce the concentration of the virus by deactivating SARS-CoV-2. When such devices are used, on the one hand, relevant evidence with regard to their effectiveness must be provided, and on the other hand, evidence must be provided confirming that the use of these devices does not result in any substances hazardous to human health (e. g. ozone, nitrogen oxides) being released into the ambient air or to any hazardous radiation. The relevant evidence should be based on recognised testing methods wherever possible (VDI EE 4300 sheet 14 [13]).

We strongly advise against the use of air treatment solutions that use disinfectants or hydrogen peroxide.

Further information on the use of air purifiers can be found in the DGUV's guidance document on the supplementary use of air purifiers for infection control during the SARS-CoV-2 epidemic [14] and the baua:Fokus publication on the use of mobile air purifiers for protection against infection [15].

Recommendations

- Before mobile air purifiers are procured, the possible use of more sustainable measures should be considered, such as upgrading with local ventilation equipment [15].
- Ensure an adequate supply of fresh air from outdoors.
- Consider the relationship between room size and air purifier capacity. In larger rooms, place mobile air purifiers close to the persons present. Consider the possible adverse effects of noise.
- Particularly suitable in this case are air purifiers based on filtration technology (e. g. class PM1 50% / ePM1 80% filters, or even better, H13/H14 HEPA filters).
- When devices that employ different air purification techniques (UV-C radiation, ionisation, plasma filters etc.) are used, on the one hand, relevant evidence with regard to their effectiveness must be provided, and on the other hand, evidence must be provided confirming that the use of these devices does not result in any substances hazardous to human health (e. g. ozone, nitrogen oxides) being released into the ambient air or to any hazardous radiation. The relevant evidence should be based on recognised testing methods wherever possible (e. g. [15]).
- We strongly advise against the use of air treatment solutions that use disinfectants or hydrogen peroxide.
- Ensure proper maintenance and servicing of the air purifiers, particularly the filters. Regularly check the performance of the air purifier.

5 Climatic conditions

In accordance with the German Ordinance on workplaces (ArbStättV) and the associated ASR A3.5, Room temperatures, and ASR A3.6, Ventilation [1], the room temperature and breathing air of indoor working areas should be conducive to good health, and unacceptable draughts should not occur. During the epidemic and whilst the associated recommendation of increased ventilation of indoor areas is in force, both impairment of employees' comfort and a possible increase in energy consumption [6] must be accepted to some degree in order for exposure to SARS-CoV-2 in indoor air to be reduced and the health of employees safeguarded.

The potential influence of air temperature and humidity upon the activity of some viruses, and thus also upon the risk of infection, is known. Influenza (flu) viruses for example remain in the air longer at low atmospheric humidities and temperatures and continue to be infectious [16]. SARS coronaviruses in general [17], and thus presumably SARS-CoV-2, are however highly resistant to environmental influences. Initial studies of SARS-CoV-2 indicate that activity decreases only at high relative atmospheric humidities of over 80 % and air temperatures above 30 °C. The setting of such climate parameters is however not desirable, and is unacceptable for reasons of comfort and room hygiene.

The size of the droplets and the quantity of aerosols varies according to the atmospheric temperature and humidity. At lower atmospheric humidities, water evaporates more quickly, reducing the size of droplets contaminated with viruses and promoting the formation of potentially contaminated aerosols. The evidence at the present time does not support the assumption however that increasing the relative atmospheric humidity to 40-60 % reduces SARS-CoV-2 activity. Additional humidification of the air to reduce the risk of SARS-CoV-2 infection is not therefore recommended. [6] [9]

Recommendation

- Changing the climate parameters of central air conditioning systems is not beneficial and therefore not necessary.

6 Summary of the main recommendations

- Ensure an adequate supply of fresh air from outdoors by means of natural or mechanical ventilation.
- Where HVAC systems are used, reduce air recirculation to a minimum and avoid entirely if possible. Where mechanical air recirculation cannot be avoided, higher filter classes should be used where technically possible, e. g. class ePM1 80% (formerly F9) rather than PM1 50% (formerly F7); if technically possible, class H13 or H14 HEPA filters can also be used.
- Operate HVAC systems at rated capacity for at least two hours before and after the building is used, and at reduced capacity at other times when the building is not in use.
- The indoor air quality can be checked by measurement of the CO_2 concentration. (Note: a CO_2 concentration of up to 1,000 ppm is acceptable; for the duration of the epidemic, the concentration should be kept below this level if at all possible.)
- The operating points (heating, cooling, humidifying and dehumidifying) of air-conditioning systems do not need to be changed.
- If possible, operate air recirculation equipment such as air conditioners (split air conditioners), fan heaters or fans only in rooms occupied by a single person, and even then ensure additional air exchange with outdoor air.
- Air purifiers should be regarded only as a supplementary protective measure for reducing the aerosol concentration in the room air, and not as a substitute for the necessary replacement of the indoor air with fresh air from outdoors. Before mobile air purifiers are procured, the possible use of more sustainable measures should be considered, such as upgrading with local ventilation equipment [15].
- Decentralised, mobile air purifiers employing filtration must be equipped with a filter from classes ePM1 50% / ePM1 80% at a minimum, or even better, with a H13/H14 HEPA filter.
- When devices that employ different air purification techniques (UV-C radiation, ionisation, plasma filters etc.) are used, on the one hand, relevant evidence with regard to their effectiveness must be provided, and on the other hand, evidence must be provided confirming that the use of these devices does not result in any substances hazardous to human health (e. g. ozone, nitrogen oxides) being released into the ambient air or to any hazardous radiation. The relevant evidence should be based on recognised testing methods wherever [13] possible.
- We strongly advise against the use of air treatment solutions that use disinfectants or hydrogen peroxide.

In addition to the recommendations for indoor ventilation stated in this Fachbereich AKTUELL, the familiar measures should still be observed such as maintaining a distance of at least 1.5 m and observing hygiene measures, and the wearing of respiratory masks or medical face masks if the minimum distance cannot be maintained. Intensive ventilation and other ventilation measures alone are not sufficient, and should be viewed as only one element in reducing the risk of infection with SARS-CoV-2. Observance of the rules for distancing, hygiene measures and masks is of primary importance.

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Further information

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