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Air filtration units to tackle the novel coronavirus

In order to efficiently remove particles and aerosols from indoor air, air filtration units must be equipped with appropriate filters, suitably sized and located, and regularly maintained. A frequent drawback is the high noise level at maximum power. If air filtration units are used to reduce the transmission risk of the novel coronavirus in insufficiently aired rooms, it is still necessary to make lasting improvements to ventilation. The risk of infection when in close contact with persons infected with coronavirus cannot be effectively reduced by air filtration units.

Background

The novel coronavirus is primarily transmitted through the excretion of liquid particles from the respiratory tracts of an infected person. Depending on the size of the particles, a distinction is drawn between droplets and aerosols (very fine droplets). While the larger droplets fall a short distance to the ground or settle on surfaces, aerosols are suspended in the air for longer periods and can spread rapidly in indoor spaces. They are emitted when infected people breathe and speak, and even more so when they laugh, shout, sing or during physical exertion. The greatest risk of infection is when in very close proximity to an infected person. This is why the general precautionary measures, such as social distancing, mask wearing and the rules of conduct when coughing and sneezing, are so important in preventing infections.

When aerosols containing the virus concentrate in indoor spaces, this can lead to transmission over greater distances indoors. To reduce this risk of infection, the FOPH recommends ensuring good ventilation (Protect yourself and others: ventilate several times a day): either through frequent natural ventilation by opening windows or through a mechanical ventilation unit that is optimally adjusted in accordance with standards and with a sufficiently high outdoor air flow rate.

Powerful air filtration units can be an additional technical measure to reduce very fine particles and thus any aerosols containing the virus in indoor air.
Air filtration units are not a substitute for the ventilation of a room or the regular and efficient natural ventilation by opening windows. Ventilation not only removes particles of all sizes from the air, it also removes gaseous pollutants, which impair air quality and have a negative impact on health, wellbeing and productivity. An air filtration unit cannot do this.[1] Sufficient ventilation is therefore a priority in all used rooms, and is also required under employment law regulations (see Art. 17 EmpO 3).

[1] Activated carbon filters can filter gaseous substances from the air as well as very small particles. However, depending on the substance, the removal efficiency varies widely and is sometimes low. Once the carbon becomes saturated, it loses all effectiveness and substances can be emitted back into the air flow.

Technical requirements and application

In order to ensure that air filtration units are used correctly and can actually effectively reduce the concentration of particles in a room, the following conditions must be met.

- The filter performance must be adequate. Filters should have high filtration efficiency for particles of <1 micron.

- However, good filter quality alone is not sufficient. At the same time, the unit performance (air flow rate or better CADR rating = cleaned air in m^3 per hour)[2] must be adjusted to the size or volume of the room. The unit must be able to change the whole volume of air in the room several times per hour (multiple air changes per hour). A high airflow rate not only results in a greater cleaning effect in the room, it is also very effective in short periods of time.

- In the context of the COVID-19 pandemic, the filter classes HEPA 13 (filtration efficiency of 99.95%), or even HEPA 14 (99.995%) are generally recommended. In practice, HEPA 14 filters are only marginally more effective in indoor areas, if at all, but require a lot more electrical power. If the air flow rate is sufficient, filters with filtration efficiency of 95% (E11, ISO ePM1 95%), or even an F9 filter (ISO ePM1 ≥ 80%) are effective, and require a lot less power.
  Regarding the performance of a unit in a room, three to six air changes per hour are recommended (so for a room volume of 200 m^3, unit performance of 600 to 1,200 m^3/h). If ventilation is rather poor and separation efficiency of the filters is lower, it is advisable to use the upper end of this range as a guide.

- The noise from the ventilator may be very intrusive when running at maximum power. This should be particularly borne in mind for use in classrooms, meeting rooms and similar settings. If units are operated at a low power setting because they are otherwise too noisy, this also reduces the cleaning effect in the room. Tolerance of noise can vary widely.
  When selecting units, guideline values for background noise in working areas can be consulted as a guide (see table below). The sound power level of a unit in dB(A) should preferably be no higher than the guideline value for the relevant use.[3] For use in classrooms, the unit‘s sound power level should not exceed 40 dB(A) . When purchasing equipment, it is worth considering units with a higher power than shown above and enquiring with the manufacturer about the sound power level at a lower power setting (db(A) at xxxx m^3/h).

[2] The air flow rate indicates how much air flows through the unit per minute or hour. The Clean Air Delivery Rate (CADR) combines the air flow rate with the efficiency of the filter for three different particle sizes, to represent smoke, dust and pollen. CADR values are calculated by measuring the concentrations of particles in a test room. The unit is placed in the middle of the room and is operated at full power.
[3] The guideline values refer to the noise level at each location in the room. Distance and obstacles may slightly reduce the noise emitted by the unit to the receiver. However, this is unlikely to be the case for people in close proximity to the unit.

Room	Sound exposure level LEX in dB(A)	
	Normal demands	Increased demands
Small office (up to 3 people)	40	35
Medium-sized office	40	35
Meeting and conference rooms	40	35
Open space office	45	40
Break rooms and duty rooms	60	55
Classrooms	40	35

Table: Guideline values for background noise (excerpt from Table 3, SUVA 66058, Noise disturbance in the workplace, in German and French only)

- The location where the unit is installed in the room can influence the cleaning effect. A suitable location depends on the type and positioning of the unit's suction and outflow openings. Obstacles in the air flow, poor air distribution in the room, and short circuits (i.e. direct suction of already filtered air) are bad. Ideally, the unit should be placed in the middle of a room. It should not be placed close to windows and doors. The air flows induced by the unit may impede comfort. In particular, permanent air flows directed at areas where there are several people can even increase the risk of infection locally because fine droplets and aerosols from an infected person can be directly carried to another person. This should be avoided.

- The power and number of units, and where they are placed, should be adapted to the room in question (or room geometry) and its use. Air filtration units are suitable for smaller rooms with little activity and where people do not move about much, e.g. for classrooms, seminar rooms, meeting rooms, maintenance rooms and offices. However, they are less suitable for large and high rooms or where there is a lot of movement in the room (e.g. corridors or transitory areas).

- Like any technical equipment, an air filtration unit needs to be regularly checked and maintained. To maintain the cleaning effect, the filters need to be changed after a certain operating time. Clogged filters can give off bad odours over time and therefore impair indoor air quality.
  The frequency with which filters should be changed varies from between about half a year to a year, depending on exposure to dust, pollen and particulates. It is therefore advisable to ensure good dust hygiene in the area where the unit is installed. Some units indicate when the filter needs changing.
  When changing the filter, you should refer to the manufacturer's operating instructions. The designated and appropriate filters for the unit must be used. Because large quantities of particles, sometimes containing components that can endanger health (biological substances, chemical substances) accumulate on the filter, protective measures are necessary when changing the filter (e.g. wearing an FFP2 mask, disposable gloves and goggles). Used filters should be carefully packed in foil bags, tightly sealed, and disposed of.
  It is recommended that maintenance and filter changes are performed by someone who has received appropriate training.

When properly configured, the cleaning effect of air filtration units in indoor air is undisputed. However. the actual effectiveness of this additional measure with regard to the risk of infection with COVID-19 in specific real-life settings is currently difficult to assess.
It should be borne in mind that risks of infection when in close proximity or in close contact with infected people in indoor areas cannot be effectively reduced using technical ventilation

and air filtration. Wearing a mask can reduce the risk, and it is a measure that can be quickly implemented to reduce airborne transmission risks over longer distances in indoor areas as well. Experimental studies and simulations show that wearing a mask is likely to be at least as effective as powerful filtration units operating in ideal conditions.