



On the Effectiveness of Air Purifiers to Improve Indoor Air Hygiene

Christof Asbach

IUTA, Institute of Energy and Environmental Technology

Indoor air purifiers are widely used to improve indoor air quality. They have gained particular attention during the corona pandemic as they can also help to decrease infection risks. The efficacy of indoor air purifiers is determined by two parameters: the filter efficiency and the air flow rate drawn through the filter. The Clean Air Delivery Rate (CADR), i.e. the product of these two parameters is therefore the commonly used metric to describe the air purifier performance. Other important factors to be taken into account are the power consumption and noise level.

Different scenarios can be taken into consideration when evaluating possibilities to improve the indoor air quality by means of an indoor air cleaner. For example, the air cleaner can be used to lower the pollutant concentration in an initially contaminated room. Once the air cleaner is switched on, the concentration exponentially decays and approaches zero. This scenario is applied in tests according to the different standards used to determine the CADR. In view of infection control, a case with an active source, i.e. an infectious person continuously emitting viruses, is another realistic scenario. When the air cleaner is switched on, the virus concentration in the room approaches an equilibrium concentration, which is defined by the ratio of the source strength to the CADR of the air cleaner, but does not depend on the room volume.

We have intensively studied the efficacy of air cleaners with a wide range of Clean Air Delivery Rates in real rooms, including offices, a meeting room and a school class room. The studies included experimental investigations, analytical calculations and numerical simulations which were generally in good agreement. The experimental and numerical studies determined the spatio-temporal distribution of the particle concentration in the rooms. The results show that the cleaned air quickly gets homogeneously distributed, irrespective of the furniture in the rooms. The spatially resolved CADR values were in good agreement with those determined according to the corresponding standard (GB/T 18801). The distribution of the clean air in the room can be described by means of a stirred tank reactor. Only in a case where the air cleaner was placed underneath a desk, the efficacy was impaired. The results further show that two or more air cleaners can be combined to improve the air cleaning efficacy and that the CADR values can simply be added, as long as the devices are properly positioned.

The studies have shown that air cleaners can improve indoor air hygiene, but in terms of infection control they should not be considered the sole solution, as they can only lower the risk of indirect infections, but cannot prevent direct infections. They further do not exchange, but only recirculate the air and can thus not replace window airing.

The importance of the different parameters, filter efficiency and flow rate, affecting the efficacy of air cleaners will be presented along with the results of the different studies and discussed in view of the usefulness of these devices in different scenarios.