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Testing of Air Purification Appliances in School Classrooms in the Context of COVID-19

Introduction

Retrospectively, almost all past infection hotspots (also known as "super-spreading events") can be attributed to events held in closed spaces.

This is based on the explanation of two main, but different, routes of infection of the SARS-CoV-2-Virus. In the direct space around an infected person (< 1.5 m) a **direct transfer** can take place due to incorporating exhaled aerosols. Concentration and size of droplets depends on the activity (whispering, shouting, coughing, sneezing) and personal characteristics of the person. When large droplets (> 5 µm) also have a high viral load, they settle towards the ground due to their relatively high own weight or can be separated out or diverted by mechanical barriers (mouth-nose protection / Perspex walls).

The path of **indirect transfer** via finer aerosol particles (< 5 µm) in ambient air is much more difficult to avoid. These particles can concentrate especially in closed spaces and thus put the people present in danger. Generally a close-meshed ventilation system offers protection against the indirect transfer of SARS-CoV-2 viruses.

At the beginning of autumn and winter such measures are increasingly difficult to implement in school classrooms without central ventilation systems (RLT systems = Raumlufttechnische Anlagen) because of lower outside temperatures. Air purification appliances can be an appropriate addition here.

Implementation

In order to evaluate the efficiency of such air purification appliances in a real situation, the Institute for Particle Technology of the Bergische Universität Wuppertal carried out a test at a Wuppertal school in September 2020. An almost square classroom measuring 140 m^3 (Fig. 1) with 15 students and 3 adults was selected.

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Two R 150 - by the company deconta - with F7 preliminary filters, H14 main filters, sound insulation and connectable UVC lamp were set up as air purification appliances on the side walls of the room. To maintain the students' ability to concentrate, the capacity of the air purifiers was reduced to 50 %, which corresponds to a sound level of 55 dB at approx. 500 m^3 / h volume flow.

Fig. 1: Panorama photo of the tested classroom (L x W x H: 7 m x 6.7 m x 3 m) with measuring devices (MG/Messgerät) and air purifiers (LR/Luftreiniger)

Optically working aerosol spectrometers, placed diagonally in the room, were used to find the existing particle load (see table 2). Whilst the measured data of MG1 were used to calculate the resulting reduction, devices MG2 and MG3 monitored the homogenous distribution throughout the entire room.

Table 1: Key data of the aerosol spectrometers used

Description	Manufacturer	Model	Size Range / µm
MG1	Palas	Fidas Frog	0.18...100
MG2	Grimm	1.109	0.25...32
MG3	Grimm	1.108	0.3...20

The reduction in concentration obtained by the use of air purification appliances was determined by means of comparing the undiminished particle load with the particle load recorded after the air purifiers had been used. Whilst the undiminished state was measured with only one person present for ethical reasons, all participants were in the room in a regular class situation with closed windows and door when the air purification appliances were activated.

Result

Based on a pre-determined, undiminished base load of 140 particles/cm^3, a consistent concentration of 56 particles/cm^3 was achieved by using an air purifier at half performance level, which constitutes a reduction of 60 %.

An air purifier, installed on the opposite wall, activated additionally and also performing at half capacity, showed a measurement average of 32 particles/cm^3, which is a reduction of 77 % (see table 2) compared to the base load.

The other measuring devices distributed throughout the room confirmed the result qualitatively.

Table 2.: Measured particle concentration and resulting reduction of various operating modes

Operation	Air exchange rate	Particles/cm^3	Reduction compared to undiminished base load/%
Undiminished	-	140	-
1 R150 @ 50 %	3,6	57	60
2 R150 @ 50 %	7,2	32	77

Conclusion

The use of air purification appliances facilitates a reduction of particle concentration by 60 to 77 %.

A threshold concentration at which infection becomes viable is not as yet known for the SARS CoV-2-Virus. Due to the impact of each human's individual state of health with regards to pre-existing illness or age, it is also questionable whether a universal value can be determined.

It is known, however, that the risk of infection, as well as the severity of the potentially emergent COVID-19 infection also decreases with decreasing virus load in the air.

With this in mind, the use of air purification appliances can be an appropriate addition to regular room ventilation, especially during the cold months of the year. The (programmed) performance adjustment of the air purifiers before lesson start and during break-times to 100 % increases the effectiveness of the appliances.

When planning an air purification concept, the following should be considered:

- Size of room
- Number of persons present
- Activities of the persons