NanoCleanAir

March 2023

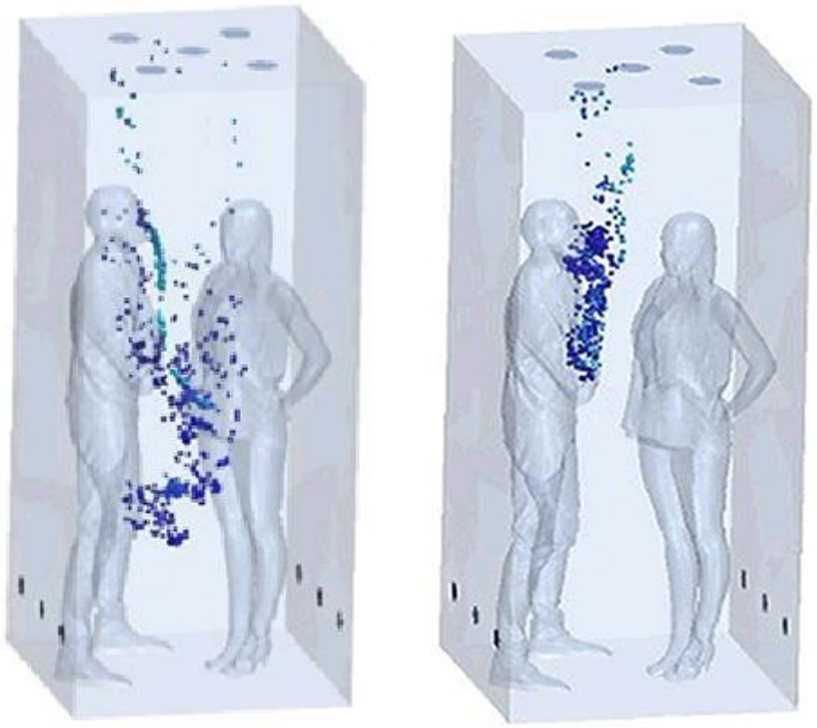
Virus protection for lift cabins

Background

The Corona pandemic has shown that a large proportion of infections occur through aerosol transmission in enclosed spaces. The same is true for many other viruses (influenza, colds). To prevent this route of infection as much as possible, aerosol transport from person to person must be minimized. Since aerosol particles can remain in the air for a long time and are distributed throughout the room by diffusion and air currents, they must be removed before they reach other people. In the NanoCleanAir (NCA) GmbH concept, this is achieved by a vertical air flow upwards. This flow is supported by thermal convection from body heat, so the direction of flow must be upwards.

The NCA concept

NCA with its partners University of Applied Sciences Northwestern Switzerland (FHNW), Adolphe Merkle Institute (AMI) and Combustion Flow Solutions (CFS) have developed a concept for virus protection in rooms. The aim is to achieve the most vertical flow possible by suction at the ceiling, filtration and recirculation near the floor, thus minimizing air exchange between people. Flow simulations show that this can be realized very well in an elevator cabin.

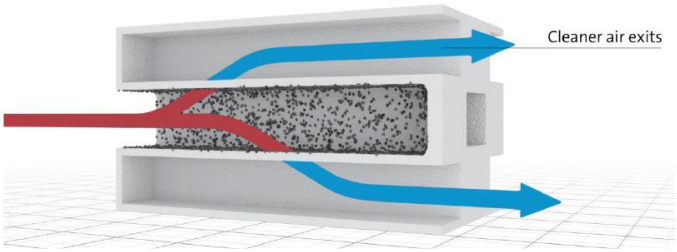


Flow simulation in a lift cabin. Left without vertical flow, right with a vertical flow of 10 cm/s.

Filter

NCA uses ceramic 'wall-flow' filters, as used for exhaust gas cleaning of combustion engines. Such filters are produced in large quantities and are therefore inexpensive, they achieve efficiencies well above 99%, can be easily heated and thus sterilized in hygienically demanding applications (hospital), are easy to clean and therefore have a very long service life in contrast to fiber filters, which have to be replaced

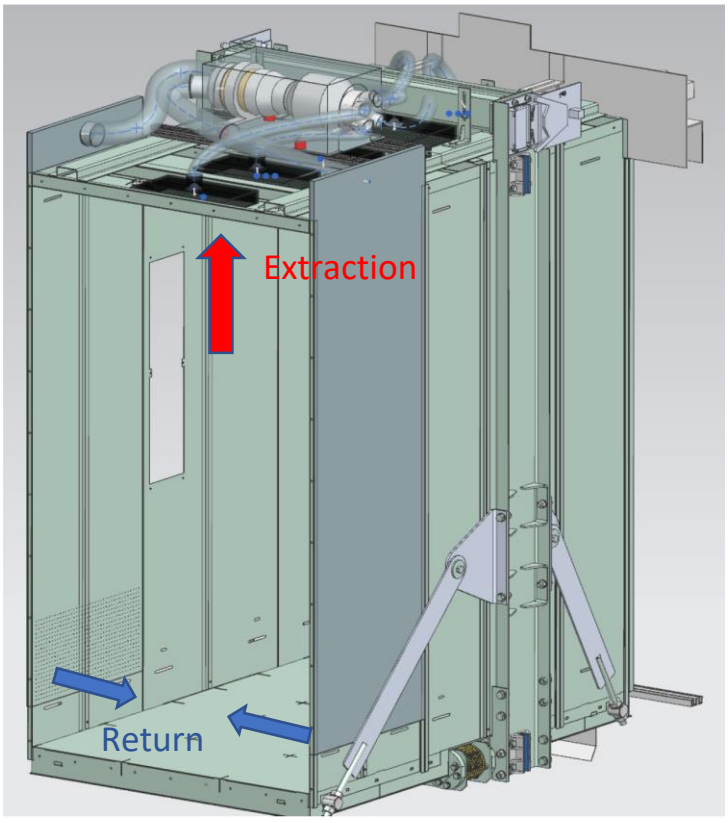
when they are occupied. Experiments show that these filters can also filter viruses highly efficiently (Rüggeberg et al., 2021[1])



The filters have a honeycomb structure, where one channel is always closed on one side, the next on the other. The air to be cleaned passes through a porous ceramic wall, particles are separated there.

Implementation for a lift cabin

In a test lift of the company Emch Aufzüge AG in Bern, a lift cabin was equipped with a corresponding system. A filter/blower unit was installed on the roof, which extracts air from the cabin through perforated plates on the cabin ceiling. The filtered air is led through a duct on the outside of the cabin to the cabin floor, where it is re-introduced into the cabin.



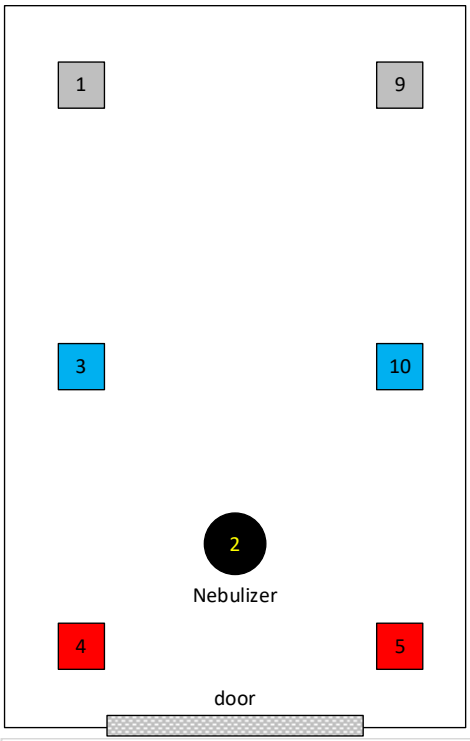
The picture on the left shows a schematic representation of the lift cabin.

The ventilation shows an air exchange rate of 27/h, the mean vertical flow velocity is 1.6 cm/s.

[1] Rüggeberg, T., Milosevic, A., Specht, P., Mayer, A., Frey, J., Petri-Fink, A., Burtscher, H., Rothen-Rutishauser, B. (2021). A Versatile Filter Test System to Assess Removal Efficiency for Viruses in Aerosols. Aerosol Air Qual. Res. 21, 210224. https://doi.org/10.4209/aaqr.210224

Results

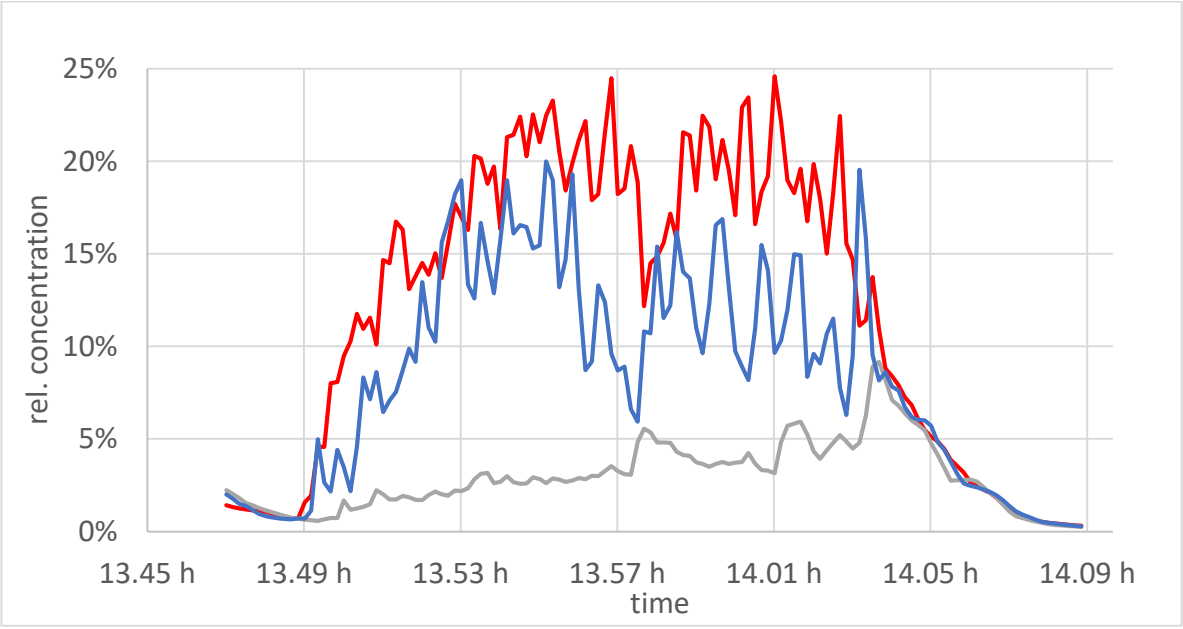
Flow visualizations using smoke show that a largely vertical flow is achieved. Although the exhaust does not reach all the way to the edge of the booth, no flow reversal is visible at the side walls.
Quantitative results were obtained by aerosol measurements. For this purpose, six scattered light sensors were suspended from the ceiling at about head height to measure particle concentration. A nebulizer used to spray a saline solution serves as the aerosol source. Another sensor measures the aerosol concentration near the source.



The picture shows the arrangement of the sensors and the aerosol source. The two sensors in the back, in the middle and in the front each showed very similar values, therefore only the average values of the two sensors are shown.

The concentrations shown are related to the value near the source. Already in the front part of the booth, i.e. close to the source (red), the concentration of the sensors is only 20% of the concentration near the source. Towards the back, the concentration drops significantly and in the rear part (gray) it is only 5% of the concentration near the source.

This shows that the horizontal dispersion in the cabin is reduced very efficiently.



Concentration in the front (red), in the middle (blue) and in the back of the lift cabin (gray) in relation to the concentration near the source.

NanoCleanAir

Applications

The principles of this solution, i.e. highly efficient purification of the breathing air from all particulate matter by nanofiltration and permanent recirculation, as well as ensuring a laminar vertical flow, which even avoids contagion of neighbors, are generally applicable and can be used in a similar form in waiting rooms of medical practices, in restaurants or meeting rooms. Even the secondary conditions, such as maintaining an extremely low noise level of 40 dB(A) and controlling the CO2 concentration, have been solved. The most important elements of this solution were anchored in patents, and the production and procurement of the core elements such as the nanofilters, the exhaust pipes and the elements for flow control were secured. Since the filters are easy to clean, there are hardly any maintenance costs and a long service life can be assumed. We do not know of any competing systems that even come close to the protection efficiency of this system and we recommend the installation in existing rooms as well as the consideration of this conception in new planning, for which we are happy to offer advice as well as the design and procurement of the special elements.

Please refer to our homepage www.nanocleanair.ch or contact us for a non-binding consultation.

NanoCleanAir: We are an engineering group that has been working for a long time on ultrafine particles in the air we breathe, their measurement, efficient filtering and prevention of their harmful effects on human health and the climate. Together with SUVA and BAFU, we created the basis for the introduction of the soot particle filter in the late 1990s, which is now the state of the art for all combustion engines worldwide, preventing millions of premature deaths and making a major contribution to mitigating the effects of global warming.

At the beginning of 2020, we decided to pool our know-how in order to develop, together with the newly founded NanoCleanAir GmbH and partners in research and industry, efficient measures against the risk of contamination by airborne bio-aerosols, especially viruses, which are similar in size to soot particles. BAFU-UTF supported our work, so that we could prove the correctness of our approach with the help of Swiss virologists from the Universities of Bern and Fribourg, and subsequently develop technical solutions for all important hot-spots.

Clean breathing air
Free of virus and nanoparticles

Analyse, filtration and
System development

NanoCleanAir GmbH
Fohrhölzlistrasse 14 b
CH-5443 Niederrohrdorf
+41 56 4966414
a.mayer@nanocleanair.ch
www.nanocleanair.ch