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Efficiency of the room air purifier from deconta (R 150) on the reduction and inactivation of airborne viruses

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The report comprises:
8 pages of text
3 figures
2 tables

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1 Object of investigation

The aim of the study was to test the reduction and inactivation of airborne surrogate viruses (enveloped Phi6 bacteriophage with comparable structure, particle size and environmental stability to SARS-CoV-2 [1], [2], [3], [4], [5]) by the air purification device (device specifications, according to manufacturer's information see Table 1) in a specially equipped test room. To mimic a classroom for the study, it was equipped with dummies, tables and chairs.

Table 1: Device specification

Device name	R 150
Manufacturer	deconta GmbH
Other product names according to manufacturer	PLR-SILENT; air Kiss; h.i. Competence
Receipt of the device	12 November 2020
Operating principle	UV-C (100-280 nm) - recirculating air cleaning process of HEPA filter class according to EN 1822: < 500 m³/h H14 certification > 500 m³/h H13 classification The R 150 was tested without an activated carbon cassette filter.
Installation	Stand-alone system for mobile use equipped with 4 casters
Fan power setting	100 %
Volume flow rate	1062 m³/h
Device dimensions	W 393 mm x D 463 mm x H 950 mm
Room size	up to 150 m²
IBP internal test number	E3435
Measuring period	Week 50

The investigations only concerned aerosols in the air. The natural half-life of the viruses (Phi6 bacteriophage) must be taken into account when calculating the efficiency of the device.

The setup was based on DIN ISO 16000-36 [6] for the investigation of airborne bacteria, realistically adapted to the specific requirements of viruses. The viruses were collected from the room air analogous to DIN-ISO 16000-16 [7]; the filters were prepared according to DIN ISO 16000-17 [8]. The number of active viruses ("virulence") was determined in the laboratory using the plaque assay method ([9], [10]).

Note: investigations of virus activity on surfaces require a different method, since the stability of viruses in liquids ("smear infection") must be considered here.

2 Method

The experiments took place in a temperature and humidity controlled test facility (IBP-Indoor Air Testcenter, IATC: 127 m³) with the following control parameters:

- Temperature of the wall space surfaces 19 °C
- Temperature of the window surfaces 15 °C
- Room air temperature ≈ 19°C
- Room air humidity ≈ 40 H%
- Dummy temperature 36 °C
- Air exchange rate 0 h-1 (static)

The air purifier was placed on casters close to the floor between the aerosol generator and the air sampler (Fig. 1). The viruses were brought into the room at a distance of 0.6 m from the inlet of the device (1062 m³/h). Dosing was initially carried out without switching on the device in order to achieve a high virus load in the room. Subsequently, the dosing and the air purifier were operated simultaneously before the dosing was inactivated to determine the virus reduction. This three-part experimental setup ran for a total run time of approximately 2 hours. Particle distribution in the room, temperature and humidity, and ozone levels were measured continuously throughout the runtime.

Figure 1: Setup R 150 air purification unit in the IATC with the aerosol generator (dosing unit), sensor technology and air sampler.

At specific times, the viruses were drawn onto an air sampler (MBASS30 Version 3 adapted for filter operation by Umweltanalytik Holbach GmbH, Wadern, Germany) and subjected to a plaque assay test for microbial analysis in the laboratory.

The impacted air samplers were processed within one hour and evaluated after 24 hours (see Figure 2).

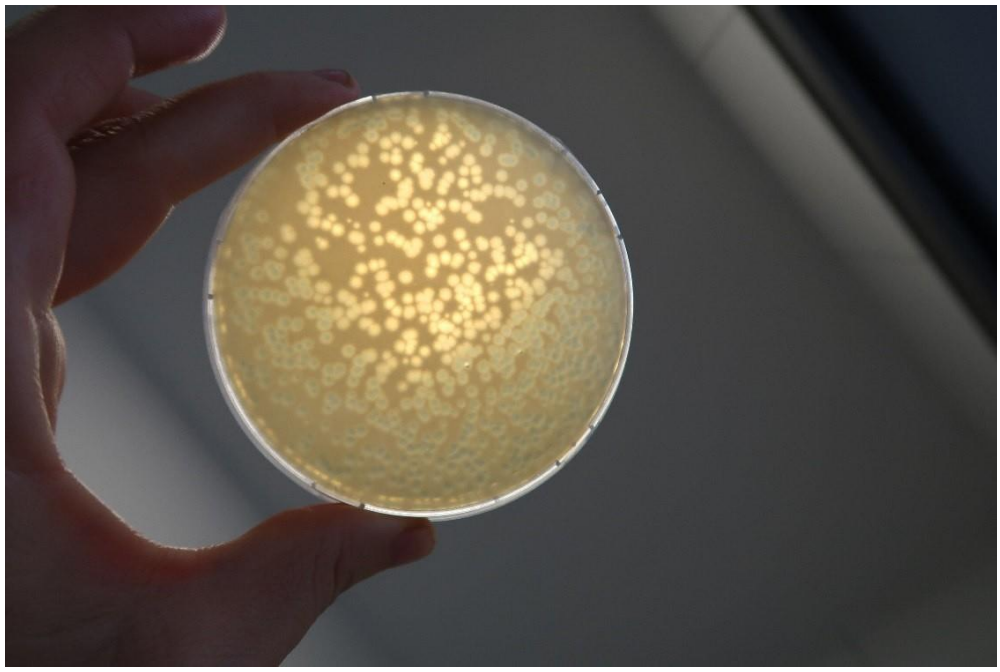

Figure 2: Microbial analysis. Agar plate with plaques caused by viruses (pfu, plaque-forming units).

3 Findings

The air purification device drew the virus-laden air through the filter channel. Inside the device, viruses were inactivated by the effect of UVC and retained by air filtration via an H13 filter due to the set volumetric flow of 1062 m³/h (fan setting = 100 %). The maximum concentration of ozone in the room itself remained low throughout the measurement period (max. 0.5 ppb, corresponding to 1 µg/m³). Figure 3 shows the distribution of viruses in the room over the measurement period. The sampling periods for the viruses in the air are color-coded in the diagram (Fig. 3). The phage dosing started at 0 min:

- **P1:** Sampling in the period from 31 min to 61 min of phage dosing and R 150 inactive (corresponds to reference measurement).

- **P2:** Sampling in the period from 69 min to 99 min of simultaneous operation by virus dosing and R 150.

- **P3:** Sampling in the period from 99 min to 129 min in simultaneous operation by virus dosing and R 150.

The two curves reflect the measuring ranges of the particle measuring instruments (P- Trak/TSI and Fidas Frog/Pallas). The P-Trak covers the nanoscale range from 20 to 1000 nm, therefore mainly covers the range of individual viruses (virus size (approx. 100 nm) in the air. The Fidas Frog encompasses a larger scale range of 0.2 to 20 µm, and this means it covers aerosol-bound viruses (approx. 1 to 3 µm).

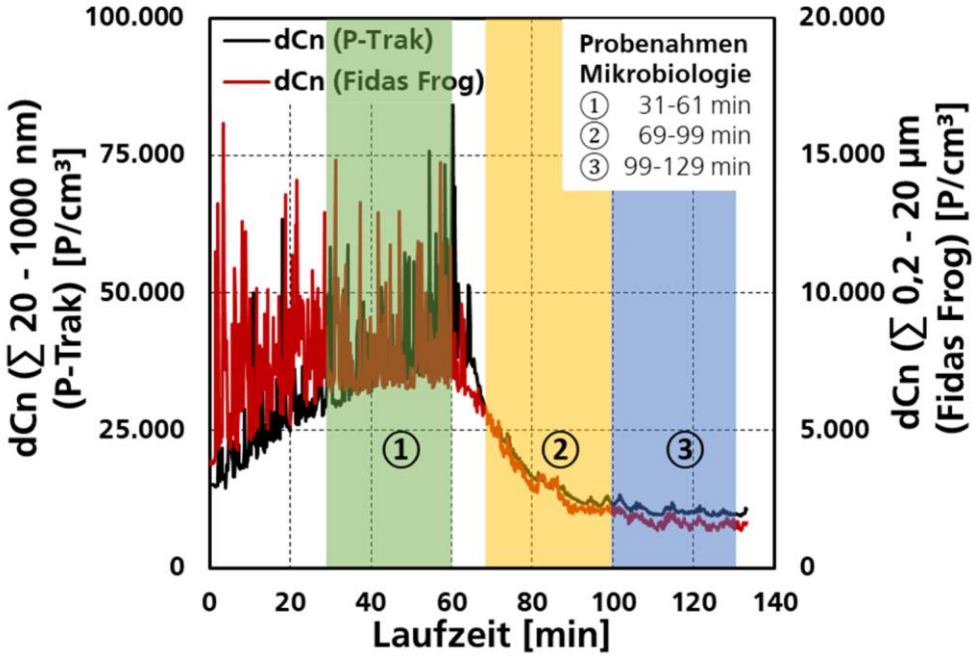

Figure 3: Distribution of virus particles in the room and sampling times.

Since the room air cleaner is based on the principle of filtration as well as inactivation of viruses, the magnitude of the reduction was determined. Table 2 shows the reduction of recovery of active viruses analyzed in the laboratory in relation to the measurement P1 (reference measurement, without the influence of the device) with continuous dosing of viruses. In addition to the effect of the device, the natural loss of activity in the suspension as a function of time also influences recovery. The virus titer (pfu/mL) of the suspension was therefore additionally tested at the beginning and end of the experiment. No significant loss of activity took place in the suspension.

Table 2: Measurement of viral activity

Time of sampling	Recovery of active units (plaque-forming units) with standard deviation [pfu/m³]	Measured reduction in recovery of active viruses (pure measured data in relation to P1) [%].
P1 max.	11,475,000 (±14%)	0
P2	4,533,333 (±18%)	60.49
P3	65,667 (±47%)	99.43

4 Summary of the investigations of the efficiency of the room air purifier of deconta (R 150).

The IATC with a room volume of 127 m³ was exposed for 2 h to surrogate viruses (enveloped Phi6 bacteriophage with comparable structure, particle size and environmental stability to SARS-CoV-2). After 1 h, the R 150 air purifier (deconta) was switched on. The air purifier ran simultaneously with the aerosol generator for 1 hour. 2 samples were taken within this hour. **The recovery of active viruses was reduced by 99.43 % after 45 minutes of device operation.**

During the test, a maximum ozone concentration of 1 µg/m³ was measured in the air. This corresponds to less than 1 % of the legally specified limit value. The Federal Immission Control Act specifies up to 120 µg/m³ as a safe upper limit (maximum target value). [11]

5 Literary sources

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