Summary Report

Efficiency of Medklinn PRO AS 500D in reducing and inactivating airborne viruses at the Cincinnati Movie Cinema, Munich, Germany

(Extracted from IBP Report No. UHS-025/2022)

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Project consortium:
- Fraunhofer Institute for Building Physics IBP
- Institute for Occupational Medicine, Safety Technology and Ergonomics e.V. (ASER)
- University of the Federal Armed Forces Munich, Institute for Fluid Mechanics and aerodynamics
- Fraunhofer Singapore
- Fraunhofer Austria
- The umbrella organization of the film industry e. V. (SPIO)

1. Background

As businesses set to reopen and with **less covid restrictions**, people look forward to life with some semblance of normalcy. Cinema operators have **intensified efforts to offer a safe environment for moviegoers**. Hygiene protocols, face masks, reduced occupancy, social distancing, and increased ventilation for cinema halls are in place but **more is needed to reduce the risk of infections**. This led to the **CineCoV Study** which was **initiated by the organisation of the film industry `Spitzenorganisation der Filmwirtschaft`, e. V. (SPIO) and funded by the German government.**

The CineCoV study was conducted by Fraunhofer Institute, **Europe's largest application-oriented research organization**. The Institute evaluated the effectiveness of different air sterilization technologies against aerosolized viruses.

The focus of this summary report is on tests conducted on the efficiency of a ventilation system operating with and without Cerafusion™ Sterilization technology.

2. Objective

The objective of the study was to test the effectiveness of the **ventilation system operating with and without Cerafusion™ Air Sterilizer** in a cinema hall, and its **impact on the reduction and inactivation of airborne viruses**.

3. Methodology

The test took place in the Cincinnati cinema in Munich (Cincinnati Straße 31, 81549 Munich) utilizing its existing ventilation system. A comparison was also made with the existing ventilation working with Medklinn PRO AS500D. The existing ventilation system operates with 10% fresh air. The test in the cinema hall was carried out with temperature-controlled dummies to simulate moviegoers. The cinema hall had 428 seats with a room size of 2252 m3.

Surrogate viruses (enveloped Phi6 bacteriophage) with a comparable structure, particle size and environmental stability to SARS-CoV-2 were used as test organisms.

The tests done were exclusively on **aerosols in the air**. The natural half-life of the virus (Phi6 bacteriophage) was taken into account when calculating the efficiency of the device.

The structure was based on DIN ISO 16000-36 for examining airborne bacteria, realistically adapted to the specific requirements of viruses. The viruses were collected from the room air on gelatine filters in accordance with DIN ISO 16000-16, and the filters were processed in accordance with DIN ISO 16000-17. The number of active viruses ("virulence") was determined in the laboratory using a plaque assay.

Test schedule

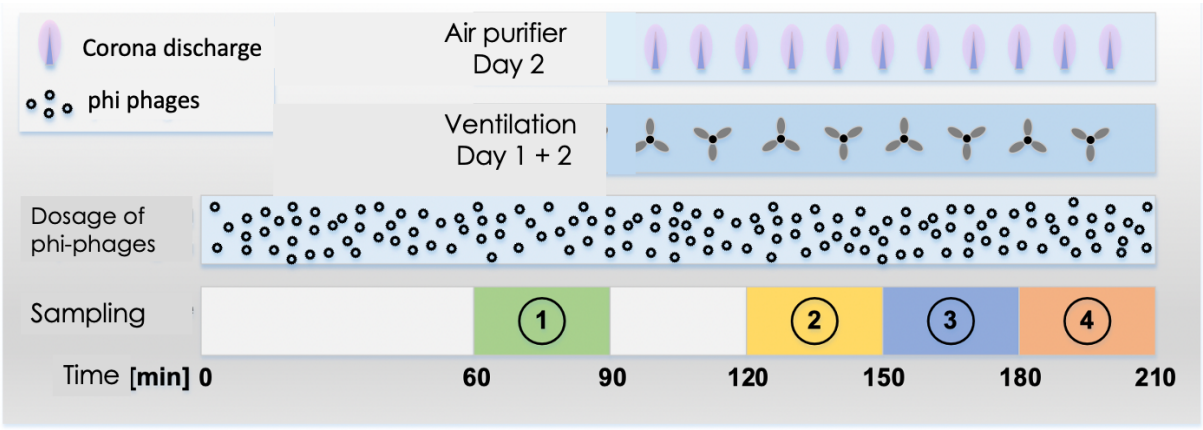
The tests were initially carried out without air exchange and after about 90 minutes the ventilation was switched on with a fresh air proportion of 10%. The temperature and humidity in the cinema hall were not set to a fixed level. The climatic conditions in the room were logged during the measurements and were in the range from 19 °C to 24°C and 45% to 60% relative humidity.

Two days of measurements were carried out and necessary for the tests to determine the influence of the air sterilizer. Measurement on day 1 (reference measurement day), the timing was identical to the second measurement day, apart from the connection of the air sterilizer, which was only in use on measurement day 2. The investigations of the two measurement days were carried out according to the following scheme (Table 1) and are graphically visualized in Figure 1.

Table 1: Timing of the two measurement days

Schedule	Measurement Process	Measurement day 1 (reference measurement day) 9/6/21	Measurement day 2 16/6/2021

		Ventilation	Air Purifier	Ventilation	Air Purifier
0 – 60 min	Virus Dosage	-	-	-	-
60 – 90 min	Virus dosage; Sampling 1 biology / chemistry	-	-	-	-
90 – 120 min	Virus Dosage	Active	-	Active	Active
120 – 150 min	Virus dosage; Sampling 2 biology / chemistry	Active	-	Active	Active
150 – 180 min	Virus dosage; Sampling 3 biology	Active	-	Active	Active
180 – 210 min	Virus dosage; Sampling 4 biology	Active	-	Active	Active
210 mins	End of trial	-	-	-	-



Note: Between 90 – 120 min, Active Oxygen is switched ON to fill the indoor space to a desired level.

Figure 1: Time visualization of both measurement days.

Devices used for measurements during the test

- Particle measurement devices (P-Trak/TSI, WCPC 3788/TSI and Fidas Frog/Pallas)
- Ozone analyzer (O3 41M/ansyco)
- NOx analyzer (AC 31M/ansyco)
- Ionometer (IM 806/ environmental analysis Holbach)
- Photoionization detector (ppbRAE 3000/Honeywell)
- Aerosol generator (AGK 2000/Palas)
- Sampling pumps (BiVOC2/ environmental analysis Holbach)

- Air sampling system for microbiology (air sampler MBASS30 with filter adapter FA 30/Umweltanalytik Holbach)

Different devices were used to collect various data to determine if there were any changes during these two days of measurements such as particle numbers, ions and volatile organic compound (VOC).

4. Summary of Results:

		Day 1			Day 2		
		Ventilation without Disinfection Device (Reference Measurement)			Ventilation with Cerafusion™ Sterilzation Technology		
Sampling	Sampling Interval (min)	Determination of active units in [pfu/m3]	Air Purifier (ON/OFF)	Reduction of Virus, %	Determination of active units in [pfu/m3]	Air Purifier (ON/OFF)	Reduction of Virus, %
1	60 - 90	12,567	OFF	0	80,111	OFF	0
	90 - 120		OFF		*	ON	
2	120 - 150	14,567	OFF	-15.92%	22 [1)]	ON	99.97%
3	150 - 180	7,467	OFF	40.58%	22 [1)]	ON	99.97%
4	180 -210	1,800	OFF	85.67%	< 22 [2)]	ON	> 99.97%

Note:
* Active oxygen is switched ON and conditioned to the desired ozone level.
1) The result is below the limit of quantification of 667 pfu/m3.
2) The result is below the detection limit of 22 pfu/m3.

The test results show that there was a reduction of surrogate viruses (enveloped Phi6 bacteriophage) **up to 85.67% at 210 mins** with the ventilation system without Air Purifier. However, the **ventilation system with Air Purifier (in Day 2) shows much greater reduction of surrogate viruses of 99.97% in a shorter time frame at 150 mins and continues to reduce to more than 99.97% at 210 mins.** Note that the surrogate viruses were continuously dosed in from the start for both Day 1 and Day 2. The Air Purifier in Day 2 is switched ON at 90 – 120 mins to fill up the cinema space before the sampling data was collected 30 mins later.

During the test, the particle distribution of virus aerosols in the room was continuously recorded over the measurement period for both days. It was found that the air purifier does not influence the reduction in the particle numbers when compared to the ventilation system.

Different volatile organic substances (VOCs) were also measured to determine if the active oxygen which released low level of ozone creates potential by-products. **The measurements indicated that the level of VOCs is at hygienically harmless level which is not significant to cause any potential harm to humans.**

5. Conclusion

Whilst the test results show that with the **ventilation system alone** there was a reduction of surrogate viruses (enveloped Phi6 bacteriophage) of up to **85.67% at 210 mins**, it was

noted that further improvement was achieved with the addition of Cerafusion™ Air Sterilizer.

The ventilation system coupled with Cerafusion™ Air Sterilizer reduced surrogate viruses further up to **99.97%. More importantly and of significant difference** was that it was done **in a shorter time frame at 150 mins** and **continued to reduce to more than 99.97% at 210 mins**, whilst surrogate viruses were continuously dosed into the cinema.