Fraunhofer IBP

PROJECT INFORMATION

CineCoV: Indoor Air Hygiene and use of Air Purification Technologies in Movie Theaters during the Covid-19 Pandemic

The coronavirus pandemic is ongoing, and infections are becoming common in the society, while we are back to enjoying our regular activities and entertainment such as going to the movies. To ensure that the movie theater experience remains and the risk of infection is reduced in indoor spaces like cinema halls, frequented by many moviegoers - safer hygiene concepts were developed and, the Federal Government Commissioner for Culture and Media (BKM) has agreed with the umbrella organisation of the film industry `Spitzenorganisation der Filmwirtschaft`, e. V. (SPIO) to initiate the "CineCov" project. An online information portal tailored to these needs with safer hygiene concepts and a ventilation configurator is now available for cinema operators. Extensive air purification technologies were also tested using aerosolized model viruses. In addition to the established ventilation measures, additional components such as air purification technologies are thus available to further reduce the risk of infection in densely occupied rooms. This helps in the current ongoing pandemic situation as well as for hygienic operation in future health crises.

In preparation for the expected rise in the number of infections during the coronavirus pandemic this autumn, cinemas are intensifying their efforts to provide a safer environment. Over the past few months, the BKM has supported the CineCov project under the auspices of Fraunhofer IBP, in which an information portal of safer hygiene concepts were developed for cinema operators and the evaluation of supplementary air purification technologies have been implemented. The established extensive hygiene and ventilation measures ensure that the rooms frequented by many people at the same time will not result in high risk of infection. Depending on the pandemic situation, this includes tightening up the mask requirements as well as reduced occupancy rates and additional ventilation measures for the cinema halls.

An information portal is now published on the official CineCov website (www.cinecov.de) consisting of a guideline on indoor air hygiene and safer hygiene concepts which are available to the cinema operators. The ASER Institute has also developed online dialogues that deal with additional questions for film theatres as well as other background relating to the associated health protection activities.

In addition, a newly developed ventilation configurator for typical arrangements in the cinema halls is available including the general information on ventilation measures tailored to the cinema operations. With this, cinema operators can input their respective data and receive an assessment of the infection load based on the selected ventilation conditions available in the configurator. In this way, the selected setting for ventilation can also be

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Kontakt
Prof. Dr. Gunnar Green | Fraunhofer Institute for Building Physics IBP | Phone +49 8024 643-228 | Fraunhoferstr. 10 | D-83626 Valley |
www.ibp.fraunhofer.de | gunnar.gruen@ibp.fraunhofer.de

documented for the specific hygiene concept. The configurator, implemented by Fraunhofer IBP and Fraunhofer Austria, is based on the propagation simulations used in the CineCov project with the Indoor Environment Simulation Suite, which was metrologically tested at three cinema halls.

For this purpose, typical cinema halls of different sizes and ventilation were considered: the Cincinatti in Munich with a large hall and mixed ventilation, the New Rex in Munich with modern displacement ventilation that is now typical for cinemas, and the Trifthof in Weilheim with a small hall and ventilation via long-distance nozzles. Flow tests with tracer gases and artificial aerosols were carried out here together with experts from the University of the Federal Armed Forces in Munich to determine their spread in the hall for comparison with the simulation. Even in large halls like the Cincinatti, a high air exchange rate of more than 5 h^{-1} could be achieved. For the hall in the New Rex with displacement air system, the great advantage of this type of ventilation of the rapid discharge of polluted air towards the ceiling was shown. This removes potentially infectious aerosols from the breathing zone before they spread in the hall. This effect could also be shown in special tests with heated dummies in comparison with a breathing person, so that ventilation of a cinema hall from bottom to top is still recommended. Directional currents, which are partially created by the ventilation, can superimpose this effect, and essentially formed in the case of the tiered halls considered along the rise. The CineCov configurator can now be used online to assess whether the air quantities stored in the concept are sufficient to keep the risk of infection comparably low.

In addition to conventional measures, additional large-scale air purification technologies can be used if necessary to further reduce the risk of infection. Using surrogate viruses (model viruses), the Hygiene and Indoor Climate Research Group at Fraunhofer IBP analyzed how many infectious aerosols can be detected in the immediate vicinity of a virus source – with and without such technologies. In (central) ventilation systems, the air is transported to the outside via the ventilation technology and fresh air is supplied to the rooms from the outside. In the case of mobile air purification devices, only the air that passes through the devices is cleaned. The technologies presented here are different. They can also be used to treat the air in the room. Therefore, two technologies were tested that can work within the auditorium: the use of active oxygen converters and upper air UV-C devices. In both cases, the load of infectious surrogate viruses at a distance of 1.3 m from the virus source was further reduced compared to ventilation alone: by 90 to 99%. Translating to an infection risk, this is reduced by a factor between about 2.5 and 7.5. For comparison, this is in the same

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dimension as the difference between the risk of infection of vaccinated and unvaccinated individuals, for which the REACT-1 study reports [1] a factor of 3.
In the Cincinatti cinema hall in Munich, the infectious viral load with and without the use of air disinfection devices based on Cerafusion™ technology was investigated. For this project, in addition to the mixed ventilation from the existing ventilation system, the cinema hall was equipped with devices that create active oxygen into the hall via eight nozzles distributed throughout the cinema ceiling. Active oxygen that produces low ozone concentration was adjusted to an average level of 120 µg/m³ ozone in the cinema hall that complies with the WHO recommendation. To determine the effectiveness of the reduction of a viral load, model viruses were constantly introduced into the cinema hall via an aerosol in an unfavorable seating location and air samples were taken at a distance of 1.3 m from the source of the virus. Compared to the reference measurement, the viral load could be reduced by > 99% at the first sampling, while no decrease was observed in the reference situation without air disinfection devices. This successfully reduced the possible risk of infection in the immediate vicinity of the virus source. The pollution of the indoor air with ozone remains to be observed very carefully – its concentration must be continuously monitored during the use of such technology in order not to exceed threshold values for health protection. Further laboratory studies showed that it is also possible to work with low ozone concentrations, which is the long-term target value of the WHO recommendation of 60 µg/m³ and at which no critical by-products could be observed.
Such technologies used under constant monitoring with sensors must then be documented according to the hygiene concept and during commissioning.

As a second technology, the infectious viral load with and without the use of upper air UV-C devices was investigated in the Trifthof cinema hall in Weilheim. These devices emit UV-C light into the open airspace below the cinema ceiling and inactivate the viruses exposed to it at a sufficient dose. The installation was designed in such a way that the radiation exposure in the seating area was below the limit value for permanent residence at a maximum of 1.55 mW/m². In addition, the cinema hall was equipped with mixed ventilation. Corresponding to the above measurement, model viruses were introduced into the hall and air samples were taken. Compared to the reference measurement, the viral load could be reduced by > 90% at the first sampling, while no decrease was observed in the reference situation without air purification. Thus, the possible risk of infection in the immediate vicinity of the virus source could also be successfully reduced with this technology. A production of potentially critical by-products above the specified guideline values could not be determined. Ultimately,

[1] https://www.gov.uk/government/publications/react-1-study-of-coronavirus-transmission-june-2021-final-results/react-1-study-of-coronavirus-transmission-june-2021-final-results and https://www.gov.uk/government/publications/react-1-study-of-coronavirus-transmission-september-2021-final-results/react-1-study-of-coronavirus-transmission-september-2021-final-results

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appropriate documentation should be available when use with this technology according to the hygiene concept and during commissioning.

Manufacturers of such air purification technologies should always indicate the effectiveness of their technology, compliance with guideline values in the production of by-products under constant monitoring with sensors, as well as documentation of commissioning procedure by qualified personnel.
This can also be accompanied by Fraunhofer IBP based on the methods developed in the CineCov project.

It should be emphasized that the use of air purification technologies examined here are to be seen in individual cases (always very high room occupancy; very unfavorable air ducts in individual room areas) as an add-on to existing indoor air hygiene concepts in accordance with the recommendations of the UBA and the BKM of March 2021 and March 2022. They are not intended to replace the recommendations and measures there, but to supplement them where necessary in individual cases.

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Project consortium:

- Fraunhofer Institute for Building Physics IBP
- Institute of Occupational Medicine, Safety Technology and Ergonomics e.V. (ASER)
- University of the Bundeswehr Munich, Institute of Fluid Mechanics and Aerodynamics
- Fraunhofer Singapore
- Fraunhofer Austria
- Central Organization of the Film Industry (SPIO)

Technical contact:

- Prof. Dr. Gunnar Grün E-Mail: gunnar.gruen@ibp.fraunhofer.de
- Dr. Thomas Negele E-mail: dr.negele@web.de

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