



Summary of Fraunhofer test report 330241-026

Qualification of a mobile air purification device for the reduction of aerosol concentration in closed indoor spaces. October 2021.

PERFORMANCE:

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INTRODUCTION:

In this summary, the most important outcomes of a series of tests on a PlasmaMade Air Cleaner, model PMAC2-230, are displayed. (The basis of the Air Cleaner is the well tested PlasmaMade GUC 1214 filter.) The main focus of the test series was to measure the ability of air cleaners, such as the PMAC2-230, to render viruses and suchlike harmless. Also, there was attention to side effects, such as ozone and the ability to reduce several volatile organic compounds (VOC's) and carbon based compounds such as aldehydes et cetera. The whole test report can be provided upon request.

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OZONE:

It can be safely assumed that the ozone level in a room does not increase due to the operation of the Air Cleaner, as evidenced by the chart below.

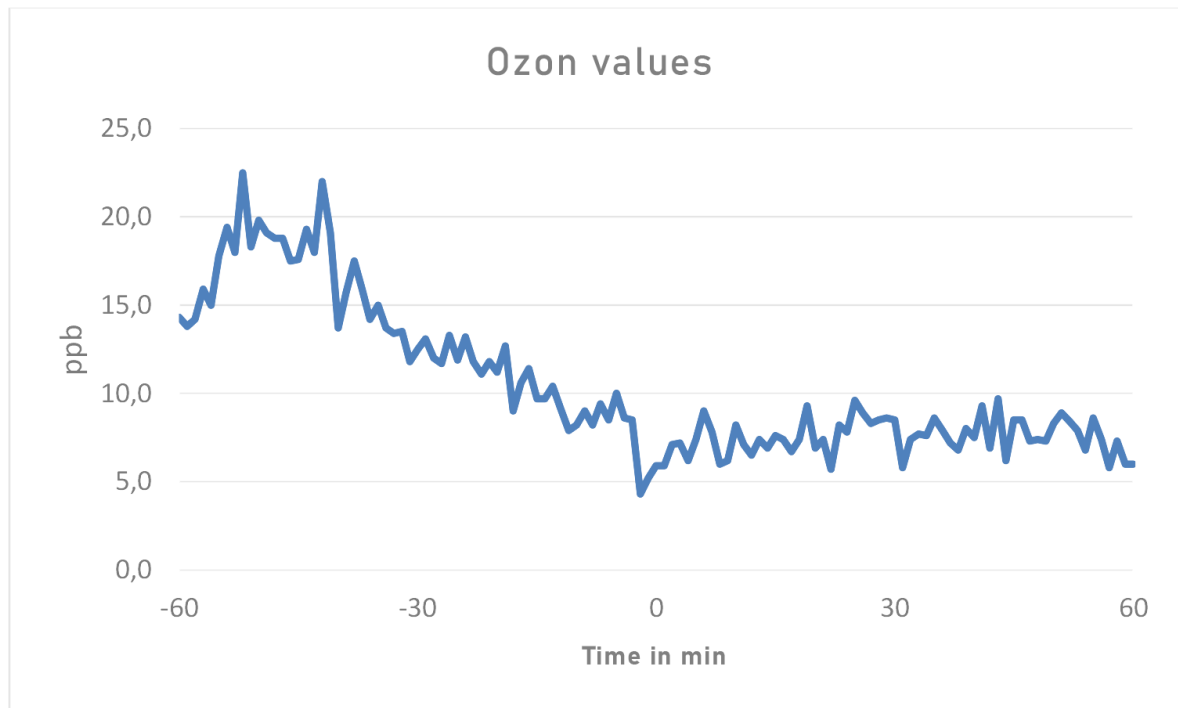


Figure 1: Ozone concentration

KETONES AND ALDEHYDES:

Also, the unit was tested for unwanted by-products in an adjacent room. The air measurement for ketones and aldehydes was carried out according to ISO 16000-3.

The following concentrations^{1 2 3} could be determined:

Name	Concentration ng/m³		
	Blank value cartridge	Supply air to air purifier	Exhaust air from air purifier
Formaldehyde	0,7	8,4	7,6
Acetaldehyde	1,3	2,4	1,4
Acroleinaldehyde	< LLOQ	< LLOQ	< LLOQ
Acetone	3,7	3,8	3,7
Propionaldehyde	< LLOQ	< LLOQ	< LLOQ
Crotonaldehyde	< LLOQ	< LLOQ	< LLOQ
Crotonaldehyde	< LLOQ	< LLOQ	< LLOQ
2-Butanone	3,1	4,8	< LLOQ
Butyraldehyde	< LLOQ	< LLOQ	< LLOQ
Benzaldehyde	2,5	4,1	< LLOQ
Valeraldehyde	< LLOQ	< LLOQ	< LLOQ
m-Tolualdehyde	< LLOQ	< LLOQ	< LLOQ
Hexaldehyde-2,4	< LLOQ	< LLOQ	< LLOQ

Table 1: Concentrations of ketones, aldehydes. (LLOQ: lower limit of quantification)

¹ The concentration is calculated from the analysed sampling volume, the detected concentration and the response of the external standard, which is also determined for each analysis batch, and the conversion factor determined via the molar mass.

² Only substances whose identity is proven by means of the reference substance "Carb Method 1004 DNPH Mix 1, 3µg/ml in Acetonitrile; Product no.: 47650-U Supelco" are quantified. The amount of acetaldehyde / acetone, 2-butanone / butyraldehyde are less certain, because these substances elute insufficiently separated from each other under the indicated chromatographic conditions.

³ The blank value of the cartridge is expressed as concentration based on the analysed gas volume of the corresponding sample for comparability.

VIRUS TEST

For testing the breakdown of viruses by an Air Cleaner, a number of surrogates were considered as replacements for SARS-CoV-2. The bacteriophage Phi6 was chosen, which with its membrane envelope and RNA genome closely resembles SARS-CoV-2, but is not harmful to animals or humans and can therefore be safely used as an aerosol for testing. These bacteriophages were cultured and a liquid culture-based scale-up procedure could be established to ensure the most efficient production of a large quantity of surrogate viruses, as required for testing on a continuous basis.

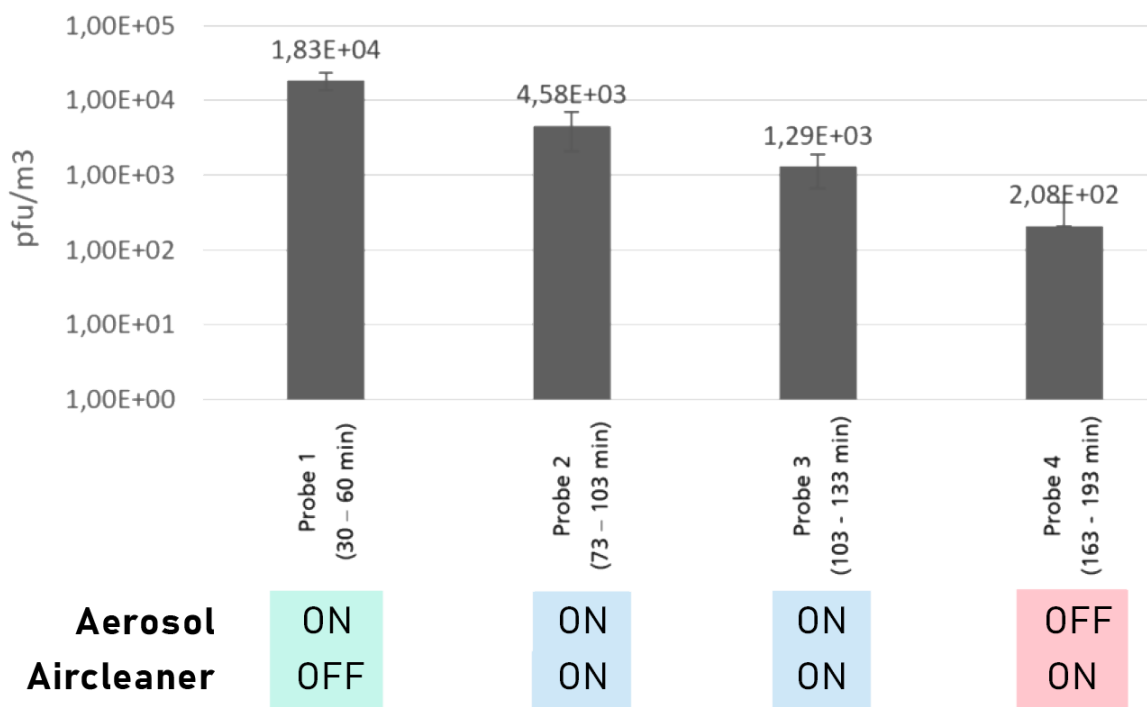


Figure 2: Representative result of the analysis of the PlasmaMade PMAC2-230 air purification device: depletion of surrogate viruses before and during air purification.

Time of sample	Determination of active plaque forming units with standard deviation, in pfu/m³	Measured reduction in the recovery of infectious viruses (measured data in relation to P1)
P1	3,08E+06	-
P2	2,29E+06	≤ Log-1 (25,68 %)
P3	9,54E+05	≤ Log-1 (69,05 %)
P4	4,17E+02	≤ Log-4 (99,99 %)

Table 2: Measurement of virus infectivity or reduction in virus recovery

PARTICLES:

As a part of the virus test, small particles were also measured. These particles can also be called aerosols, and are able to carry viruses and can infect people with disease, especially when 1 (or more) person(s) is already infected and contagious. An air cleaner which reduces these aerosols in a substantial amount will provide adequate protection against contamination with viruses, bacteria et cetera.

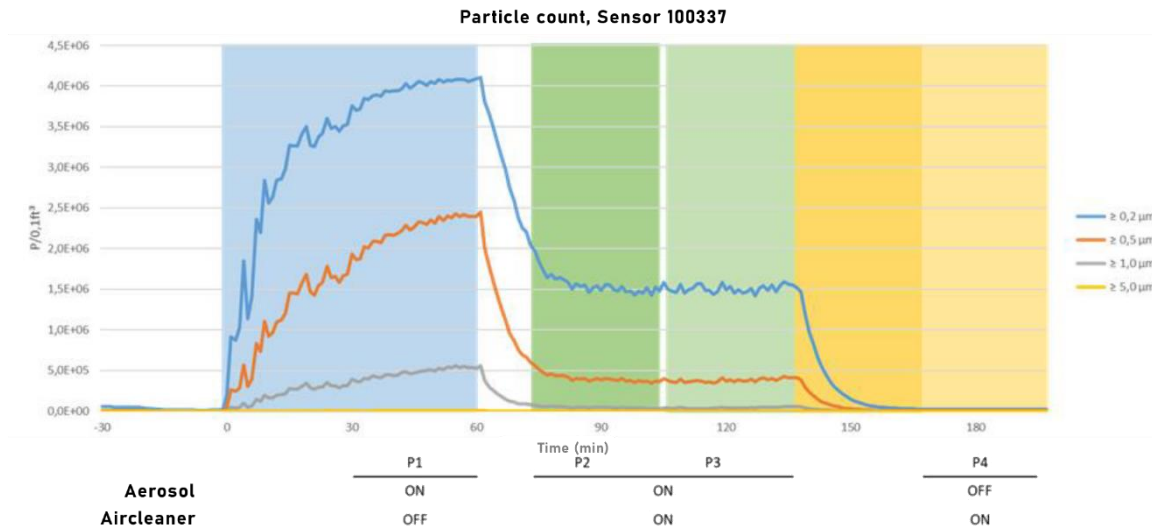


Figure 3: Representative result of the analysis of a PlasmaMade Air Cleaner: particle emission before and during air purification. It is clearly visible that at the moment when the Air Cleaner is active, particles are radically reduced, even though aerosols continue to be inserted in the test room.

CONCLUSION(S):

Some conclusions can be drawn from the series of tests conducted by the Fraunhofer institute:

- The PlasmaMade PMAC2-230 Air Cleaner does not contribute to the ozone level in any given room (figure 1).
- Dangerous carbon-bases ketones and aldehydes are notably reduced by use of the Air Cleaner.
- Particles (which can be seen as aerosols and/or particulate matter) smaller than 5.0 μm (1 μm is one millionth of a metre), and to diameters as small as 0.2 μm , will be reduced by log-5 (99.999%) in less than 30 minutes.
- It has been proven that a log-4 reduction (99.99%) of viruses can be achieved by the PlasmaMade Air Cleaner PMAC2-230 in 60 minutes, but even after a mere 30 minutes, the inactivation is over 90% (log-1).