ASHRAE Hellenic Chapter

ΤΕΕ

ENERGY IN BUILDINGS

EMEA 2024

Europe, the Middle East & Africa

FRIDAY - SATURDAY

NOVEMBER 22-23, 2024

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Independent Validation of Products which Improve Indoor Air Quality

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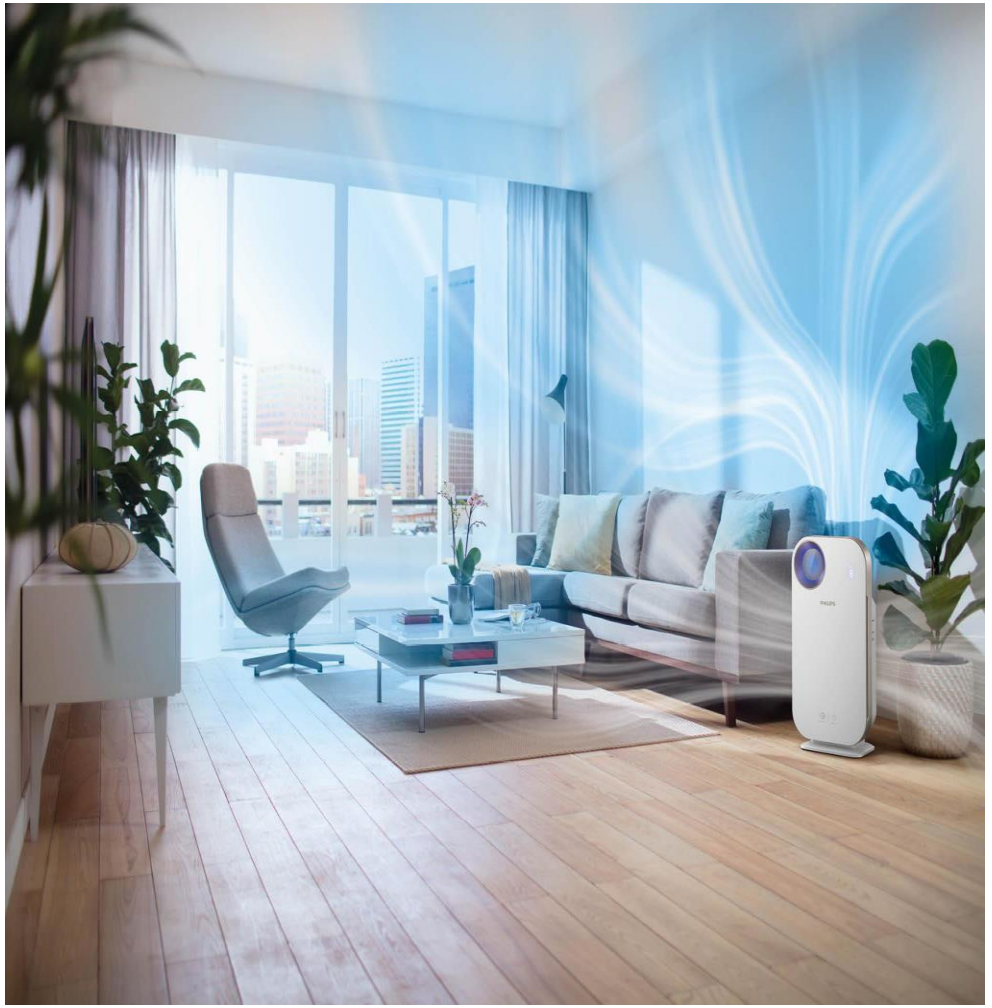
AGENDA

- BACKGROUND
- METHODS
- RESULTS
- CONCLUSIONS
- OVERALL CONCLUSIONS
- REFERENCES

BACKGROUND

- Air cleaning technologies play a crucial role in improving indoor air quality, making it essential to verify their effectiveness and safety.
- This study evaluates the performance of two in-duct air cleaning technologies, (A) UV device and (B) electrostatic device, using established standards to ensure accuracy and reliability.



METHODS

- Testing was conducted using a modified ASHRAE 52.2 test duct[1] (61 x 61 cm) attached to a 28.5m^3 Environmental Testing Chamber (Figure 1).
- A challenge particulate was introduced upstream of the test device (UV or electrostatic) and the impact was quantified downstream.
- Figure 2 shows a general schematic of the modified 52.2 test duct set-up

Figure 1: 28.5m^3 chamber and adjoining modified ASHRAE 52.2 test duct

MODIFIED ASHRAE 52.2 TEST DUCT[1]

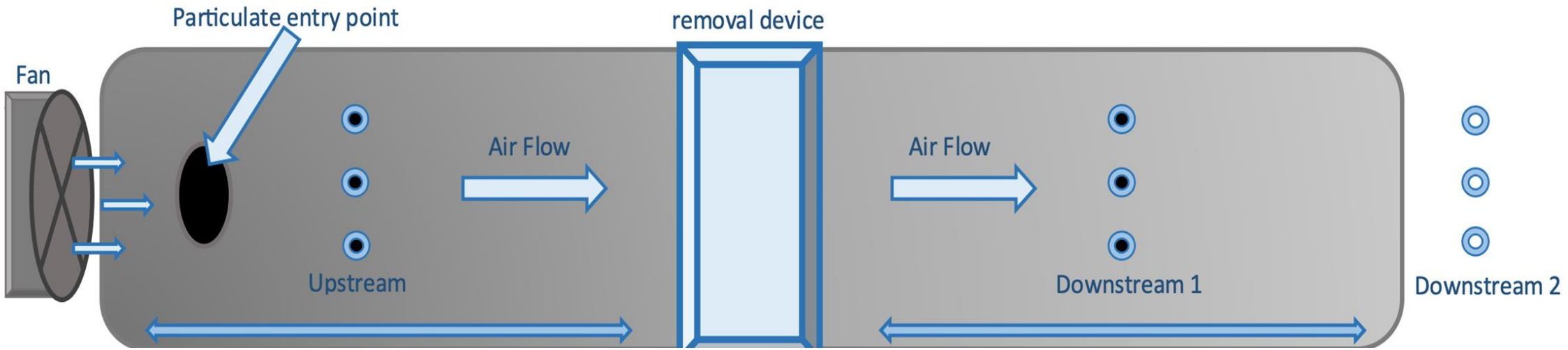


Figure 2. Schematic of the test duct set-up with the test device (UV or electrostatic) operating downstream from the challenge particulate introduction

METHODS: UV-DEVICE

MS2 bacteriophage challenge was introduced upstream of the UV device (Figure 3). The blower fan was operated at a specified rate of 500 feet per minute (FPM) for single pass test.

Triplicate air samples were collected upstream of the device and downstream in duct and chamber.

MS2 viral particles were quantified as the number of plaque forming units (PFU) per m^3 of air by plaque assay.

The average values (n=3 active/inactive runs) were reported logarithmically ($Log_{10}PFU/m^3$).

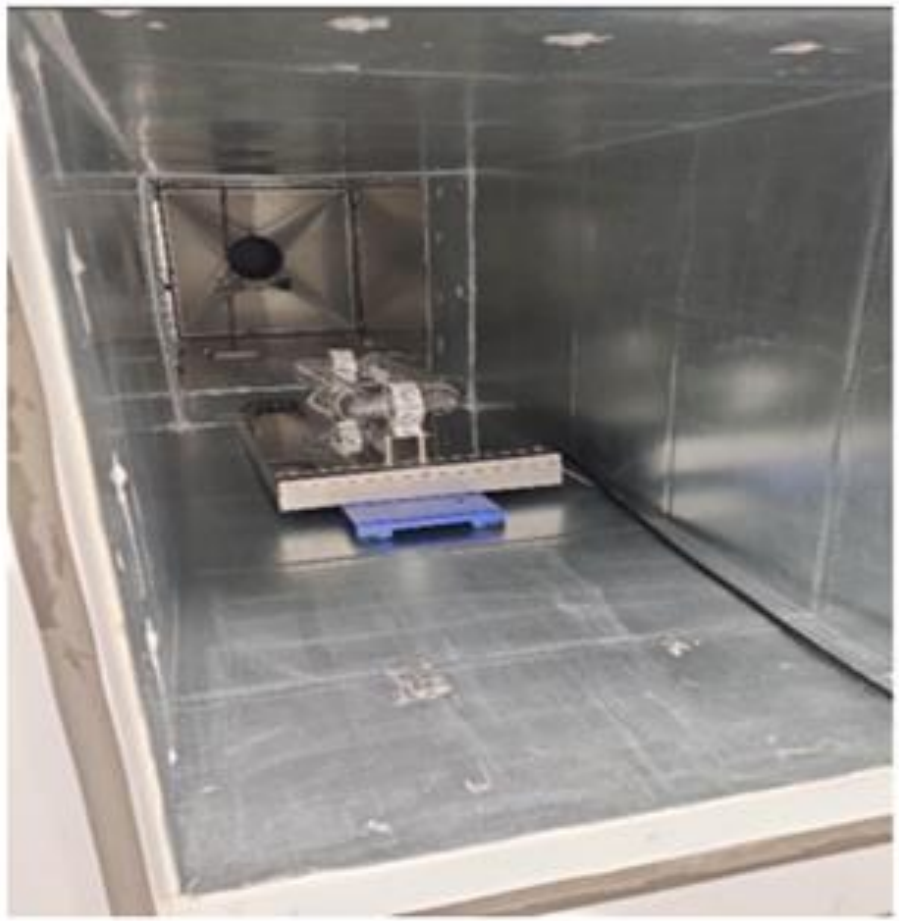


Figure 3: UV device installed in test duct for single pass test

RESULTS: UV DEVICE

Control Runs – MS2 Concentration (PFU/m³)						
	Run 1	Run 2	Run 3	Average	Standard Deviation	Log 10
Downstream 1	3.86 E+08	4.43 E+08	4.76 E+08	4.35 E+08	4.58 E+07	**8.64**
Downstream 2	4.14 E+08	4.14 E+08	3.79 E+08	4.03 E+08	2.02 E+07	**8.60**

Test Runs – MS2 Concentration (PFU/m³)						
	Run 1	Run 2	Run 3	Average	Standard Deviation	Log 10
Downstream 1	4.52 E+08	2.73 E+06	5.17 E+06	4.14 E+06	1.27 E+06	**6.62**
Downstream 2	4.44 E+06	2.10 E+06	3.43 E+06	3.31 E+06	1.18 E+06	**6.52**

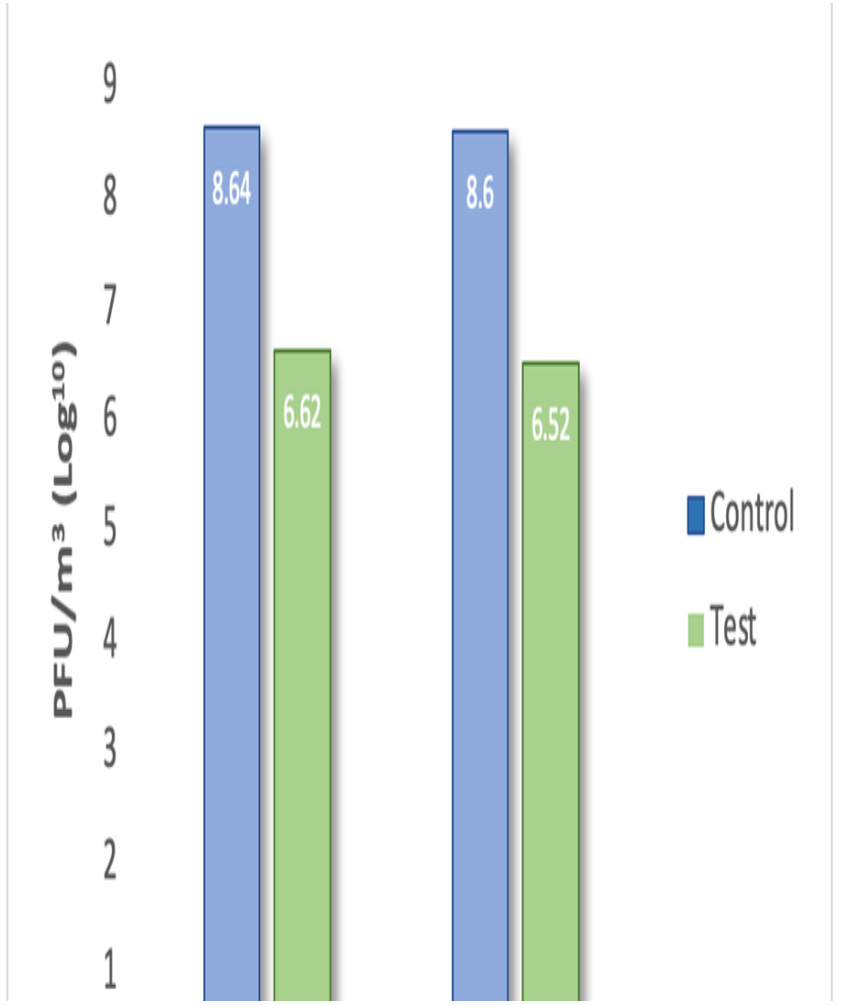


Figure 4. Quantification of plaque forming units PFU/m^3 (Log_{10}) in control and test runs, demonstrating device efficiency. Downstream 1 was the test duct, downstream 2 was the chamber

CONCLUSIONS: UV DEVICE

- The UV device reduced MS2 by 2.02 $\log_{10}$ in the duct air samples, and by 2.08 $\log_{10}$ in the adjoining chamber air samples (Figure 4).
- This resulted in an overall single pass reduction of 2.05 $\log_{10}$, which equates to **99.1**% reduction.

METHODS: ELECTROSTATIC DEVICE

- For this testing the challenge material was Allergen Test Dust (ATD), containing house dust mite (Der p 1), cat dander (Fel d 1) and Timothy grass (Phl p 5) allergens.
- ATD was introduced (Intro 1) into the test rig upstream of the electrostatic device (Figure 5), this was followed by a room disturbance (RD1).
- 2 additional introductions were performed (Intro 2 & 3), each followed by RD2 and RD3. RD4&5 were each followed by Natural decay (ND 1&2). RD6 was carried out the next morning.
- The effective removal of allergens and particles was quantified downstream in the duct and the chamber for each of these test stages, as shown in Figure 6 and 7 below.

Figure 5: Electrostatic device installed in the test rig

RESULTS: ELECTROSTATIC DEVICE

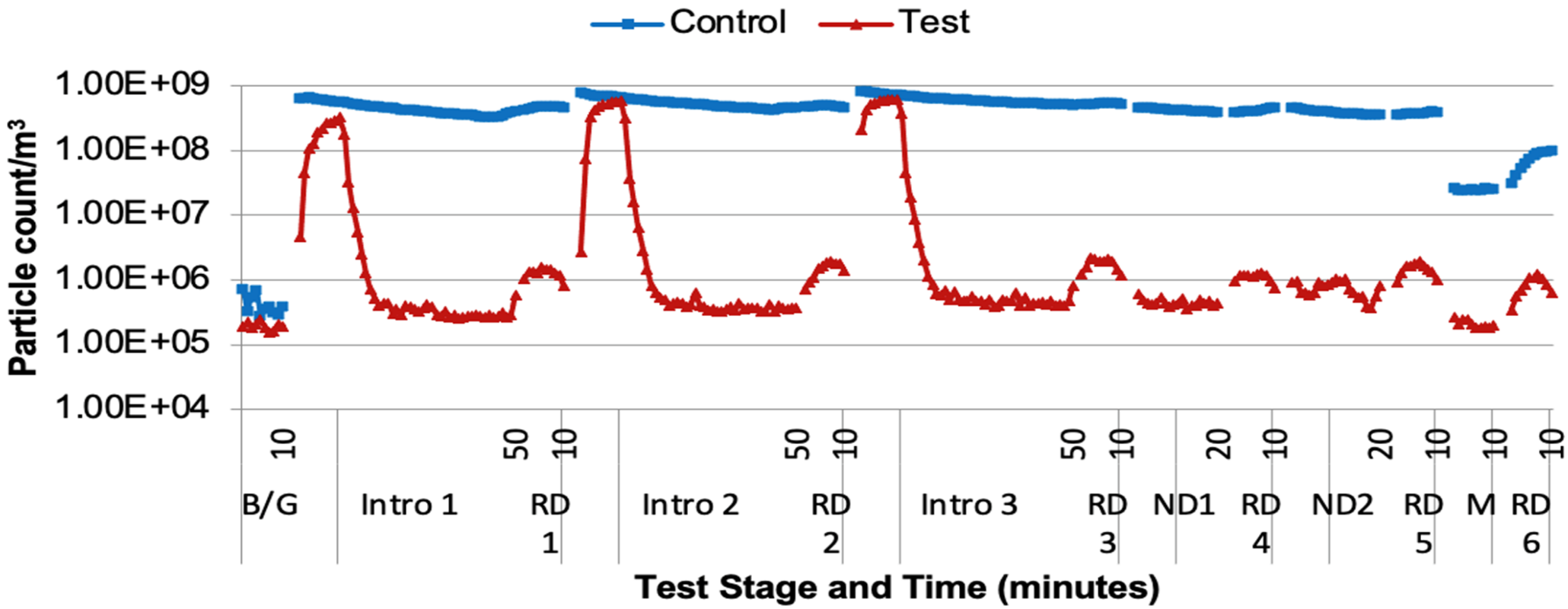


Figure 6. Particle counts in-duct during control and test runs. Test stages consisted of background (B/G), ATD introductions (Intro 1-3), Room Disturbances (RD1-6), natural decay (ND1, ND2) and the next morning (M) before RD6

RESULTS: ELECTROSTATIC DEVICE CONTINUED

Airborne Der P 1 (ng/m^3) Duct			
Test Stage	Control	Test	% Reduction
Background	11.69	4.90	N/a
ATD Intro 1	42.74	1.10	97.4
ATD Intro 2	42.18	14.89	64.7
ATD Intro 3	52.97	8.06	87.8

Airborne Fel D 1 (ng/m^3) Duct			
Test Stage	Control	Test	% Reduction
Background	11.48	2.57	N/a
ATD Intro 1	263.80	2.25	99.1
ATD Intro 2	352.49	7.22	98.0
ATD Intro 3	384.92	3.83	99.0

Airborne Phl P 5 (ng/m^3) Duct			
Test Stage	Control	Test	% Reduction
Background	4.53	1.42	N/a
ATD Intro 1	15.93	0.61	96.2
ATD Intro 2	13.90	1.52	89.1
ATD Intro 3	17.16	0.84	95.1

Figure 7. Airborne Allergen levels in-duct during the first ten minutes of fan operation after ATD introductions 1-3

CONCLUSIONS: ELECTROSTATIC DEVICE

- Total airborne particle counts increased from background levels to >$1x10^8/m^3$ during 3 sequential ATD introductions and then rapidly decayed due to removal by the electrostatic device (Figure 6). Subsequent room disturbances demonstrated limited particle count increases. By comparison, in the absence of the device, airborne particle counts remained just below $1x10^9/m^3$.
- The % airborne allergen reduction was ~90%, in most instances, compared to natural decay (Figure 7).

OVERALL CONCLUSIONS

- Demonstration of the efficacy and safety of air cleaning technologies is paramount for mitigating the spread of airborne infectious aerosols[2] and pollutants in indoor spaces.
- Testing in a specialist IAQ laboratory with advanced equipment and expertise provides third-party assurance of the technologies' performance and safety.
- Furthermore, collaboration with an established third-party laboratory, experienced in bioaerosol testing (virus, bacteria, allergen, mould) enables the generation of reliable data for claim verification for air cleaning technology manufacturers[3].

REFERENCES

- 1) ASHRAE Standard 52.2-2017, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
- 2)) https://airmidhealthgroup.com/ashrae-standard-241.html
- 3) ANSI/ASHRAE Standard 185.3-2024, Method Of Testing Commercial and Industrial In-Room Air-Cleaning Devices And Systems For Microorganism Bioaerosol Removal Or Inactivation In A Test Chamber

THANK YOU

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