Second MIST Webinar: Future of Air Cleaning Technologies

30th October 2025

Moderator: Marcel Loomans (TU Eindhoven)

Presenters:

- Fahmi Yigit (University of Twente/Virobuster)
- Dr Erica Ding (TU Delft)

This webinar was organized by the MIST (MItigation STrategies for Airborne Infection Control) project, funded by the Dutch Research Council (NWO).

The **MIST project** brings together leading Dutch universities, medical centers, and industry partners to develop effective mitigation strategies against airborne infections. By combining expertise in **ventilation, air cleaning, epidemiology, and social sciences**, MIST aims to create scientifically grounded and practically applicable solutions for healthier indoor environments. MIST is structured into five interconnected **work packages** covering:

- Airborne pathogen epidemiology,
- Droplet spread dynamics,
- Ventilation and air cleaning system design,
- Real-life use cases, and
- Strategy integration and dissemination

The MIST project spans from fundamental research to practical implementation. The participation of industrial and societal partners ensures that the developed strategies address real-world needs and are feasible in various building contexts.

The **MIST webinar series**, part of Work Package 5, highlights the project's focus on **knowledge sharing** and collaboration between academia, industry, and policymakers.

Insights on ventilation and air cleaning performance

Fahmi Yigit, Air quality and ventilation specialist and a guest PhD candidate at the University of Twente, emphasised that the pandemic revealed widespread misconceptions about the performance of ventilation systems and mobile air cleaners. Many people assumed these systems provided sufficient protection, yet **testing standards such as the Clean Air Delivery Rate (CADR)** often exaggerate performance because they rely on **unrealistic, artificially mixed test conditions**.

To correct this, Yigit introduced the **Hygienic Air Delivery Rate (HADR)** metric, which measures an air cleaner's performance under realistic conditions without artificial mixing. Computational Fluid Dynamics (CFD) simulations revealed that devices with poor flow design primarily circulate air locally, failing to effectively clean the entire room.

Field studies in open-plan offices supported these findings: **measured air exchange rates were up to 60% lower than nominal values**, depending on airflow design and exhaust placement. This highlights the need for **post-validation testing** and **stricter performance standards** to ensure users can trust manufacturer claims.

Field validation in classrooms

Dr Erica Ding, a post-doctoral researcher at the Delft University of Technology, presented extensive research evaluating more than **300 mobile air cleaners**, narrowing the sample to seven for detailed lab and field testing in school environments.

Laboratory results demonstrated that airflow direction and device placement have a significant impact on performance. Air cleaners with upward airflow distribute clean air more effectively, while larger rooms require multiple devices. However, most units had to operate at maximum fan speed to reach sufficient air delivery rates, exceeding acceptable classroom noise levels (35 dBA).

Field studies across **five primary schools** confirmed substantial reductions in **PM2.5 and PM10 concentrations** during operation, while CO_2 and VOC levels remained stable. Teachers appreciated the improved air quality but reported issues with **noise, drafts, and space use**, which reduced satisfaction over time. School managers supported continued use but called for clearer evidence linking air cleaning to health benefits.

Dr Ding concluded that mobile air cleaners can play an important role in improving indoor air quality in classrooms, provided that **device selection, placement, and comfort** are optimized.

Real-world validation: the CLAIRE project

The **CLAIRE project**, complements MIST by examining the differences between standard laboratory tests and real-world performance. Comparative tests in small (28.5 m^3) and classroom-sized (10 × 7 × 3 m) rooms showed that **standard fan-mixed decay tests** tend to **overestimate effectiveness by about 10%**.

A large-scale intervention study in **over 100 classrooms** is currently underway, assessing particulate matter, CO_2, and biomarkers to evaluate both physical and biological effects of air cleaning. Collaboration with **Utrecht University** adds expertise in biomarker analysis, linking improved indoor air quality to potential health benefits.

Strategic challenges and future directions

Despite significant progress, challenges remain in connecting air cleaning technology to real infection risk reduction. **Epidemiological data** are limited due to privacy and behavioral factors, making it difficult to establish direct health outcomes. Furthermore, indoor air quality solutions must be **tailored to specific settings,** hospitals, schools, and offices, all of which have different occupancy patterns and exposure durations.

Practical barriers also persist. **Noise, drafts, and spatial constraints** continue to limit user acceptance of mobile air cleaners. Future designs need to balance performance, comfort, and energy use.

Experts agreed on several key priorities for the field:

- **Develop harmonized, realistic testing standards** such as HADR.
- **Verify performance after installation** to prevent false safety assumptions.
- **Conduct long-term field studies** combining physical, biological, and epidemiological data.
- **Foster cross-sector collaboration** to ensure solutions are both technically sound and socially acceptable.