Implementing a Microenvironment Strategy to Sustainably Optimize Indoor Air Quality in Your Building

The American Society of Heating, Refrigeration and Air-Conditioning Engineers[1] (ASHRAE)'s Epidemic Task Force recently updated core recommendations for reducing airborne infectious aerosol exposure in response to the ongoing Covid-19 pandemic. These recommended changes are based within limits that ventilation, filtration, and air cleaners can be deployed flexibly to achieve exposure reduction goals subject to constraints that may include comfort, energy use, and costs.

Specific to this paper, Stark Tech has identified indoor air quality strategies and technologies to address and achieve the recommended air changes per hour (ACH) of 6 to 10 ACH and air cleaning and filtration levels. This includes using combinations of filters and air cleaners that achieve MERV-13 or higher for recirculated air by Heating Ventilation Air Conditioning (HVAC) systems.

In response, Stark Tech, in collaboration with Healthway, developed a cost-effective solution that decouples the HVAC and ventilation systems in indoor spaces to provide an additional 4 to 10 ACH per room, creating optimal airflow at room level. Healthway's patented disinfecting filtration system (DFS) is built into the design to create sub-micron filtration, capturing particles that meet and exceed HEPA standards of 99.97% at 0.3 micron, creating "mini cleanrooms" within each space.

Designing Indoor Air Quality Solutions that are Sustainable & Cost Effective

On average, people spend roughly 87% of their time indoors, so one can see the impact indoor air quality has on the quality of life of individuals. According to the World Health Organization (WHO), there's a direct correlation between poor indoor air quality (IAQ) and adverse effects on the respiratory health of the young, elderly, and those who suffer from cardiovascular and / or chronic respiratory diseases.[2] Poor air quality can also lead to other health problems, including nausea, skin irritation, sick building syndrome, etc. It's estimated that 1 in 13 Americans suffer from asthma with an associated annual economic impact of $82 billion, according to the Environmental Protection Agency (EPA).[3]

Sources:

1. https://www.ashrae.org/about/news/2021/ashrae-releases-standard-62-1-user-s-manual
2. https://foobot.io/guides/iaq-standards-and-guidelines.php
3. https://www.epa.gov/iaq-schools/reference-guide-indoor-air-quality-schools#IAQRG_Section1
4. https://www.cdc.gov/coronavirus/2019-ncov/faq.html
5. https://online.fliphtml5.com/zcdx/snjz/#p=1
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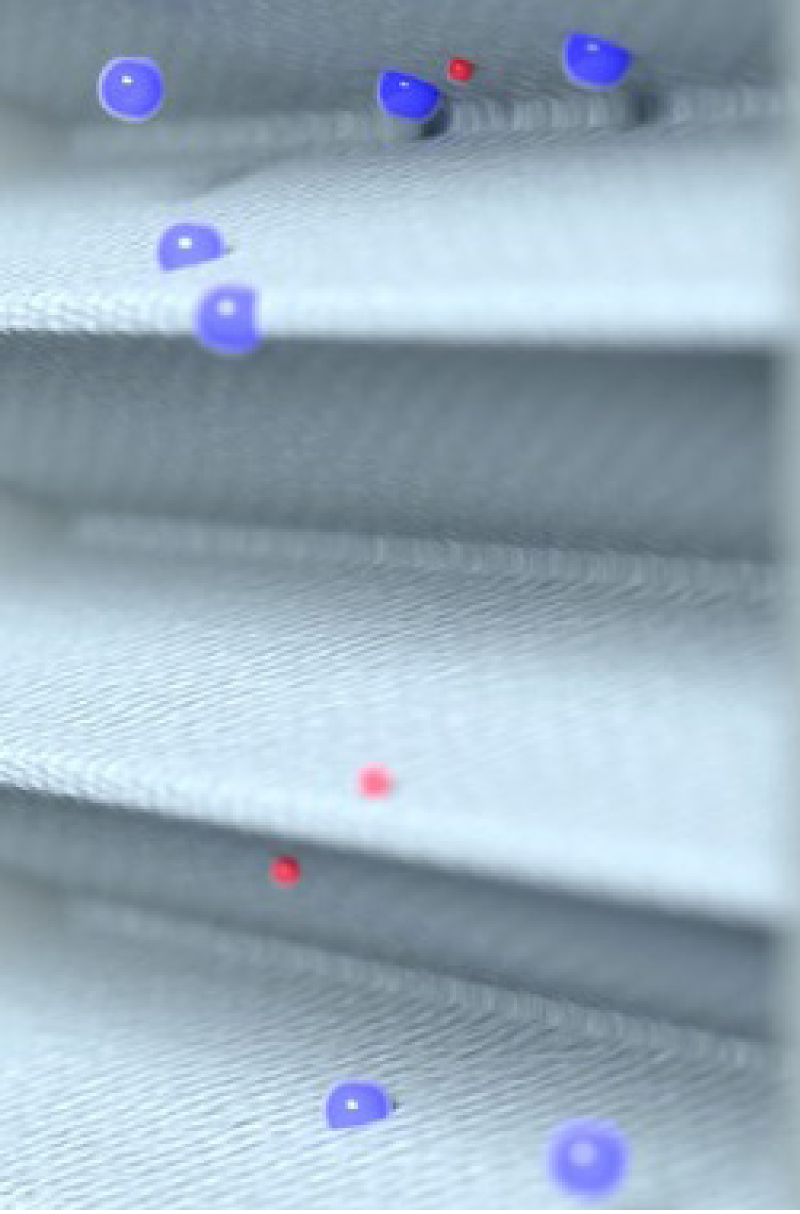


STARK TECH

Delivers total facilities optimization through technology, expertise, and customized service solutions to provide our customers with integrated building controls, equipment, and analytics.

We are a collaborative, cross-functional team working together to provide integrative, cost-effective solutions with in-house expertise for any type of building, portfolio, or project.

Studies even suggest that up to 65% of asthma cases in school aged children could be prevented with proper IAQ in school and at home settings.

This concept is not new; the WHO has been discussing the social and economic impacts of proper indoor air quality for decades. However, in 2020, when the world shut down because of the ongoing global pandemic, indoor air quality concerns jumped to the top of the priority list for the safe re-opening of buildings.

According to the CDC[4], coronavirus is spread in three main ways:

1. Breathing in air when close to an infected person who is exhaling small droplets and particles that contain the virus;
2. Airborne particulates containing small droplets of the virus that land on the eyes, nose or mouth;
3. Touching eyes, nose, or mouth with hands that have the virus on them.

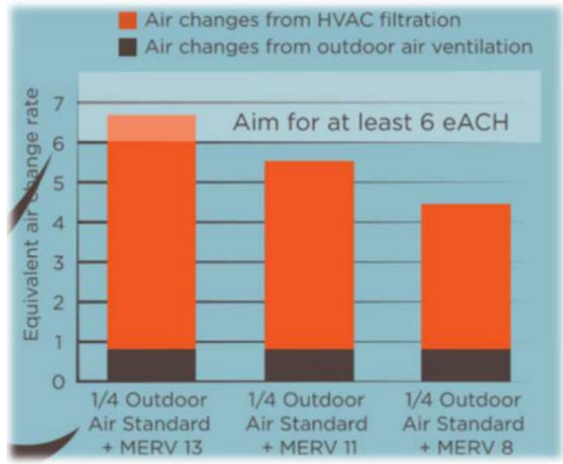
The pandemic highlighted the importance of indoor air quality to control and prevent the spread of Covid-19. HVAC and ventilation systems are implemented to address comfort indoors, but there are several ways that an HVAC system degrades indoor quality. For instance, by spreading dust, bacteria, allergens, and/or other harmful substances.

ASHRAE's updated guidelines, in conjunction with the Centers for Disease Control (CDC), recommends:

- Implementing a solution that uses a combination of filters and air cleaners to achieve MERV 13 or better;
- Maximize ventilation by disabling any demand control ventilation;
- Increase air changes and keep systems running longer – 24/7 if possible;
- Use building controls to maintain temperature and humidity levels at 72-degrees Fahrenheit (F) and 40% - 50% relative humidity (RH) in winter months, and at 75oF and 50%-60% RH in summer months;
- The recommended flush cycle between occupied periods is also recommended at 3 air changes of clean air supply

According to New York Schools Insurance Reciprocal (NYSIR)[5], approximately 53% of public-school districts need to update or replace multiple building systems in their schools, and 45% of districts need to renew or upgrade HVAC systems in at least half of their schools, representing an estimated 36,000 schools nationwide.

FILTRATION



Constraints on capital, operating expenses, skilled trades resources, and supply chain may give building owners pause in upgrading infrastructure. Instead, decision makers evaluate and often implement short-term options to address covid concerns, which ultimately create new inefficiencies within the space.

Of some of the options on the market, ASHRAE[6] and CDC found that units featuring ionizers, precipitators, or ozone generators do not help with IAQ and instead generate harmful byproducts.

The most recommended measure is to increase ventilation within spaces; however, existing HVAC infrastructure is not designed to bring in more outside air. In addition, existing critical infrastructure, like boilers, chillers, and fans, are not designed to move or condition more air, and therefore does not address the need for more total air changes with proper air distribution and higher filtration ratings.

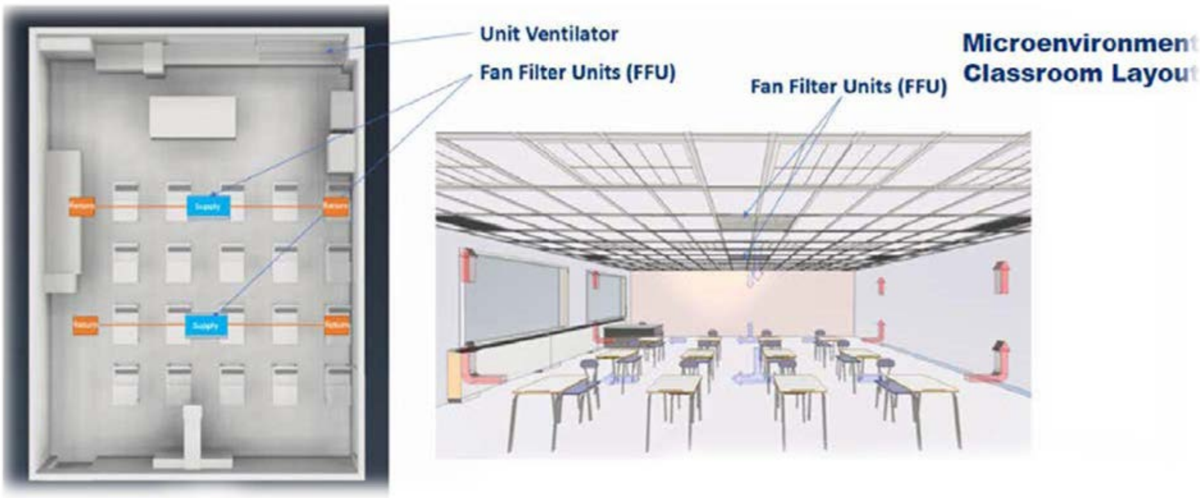
A Cost-Effective Solution to Address Indoor Air Quality

Stark Tech, a leader in facility optimization, and Healthway, a global leader in air purification systems, engineered a fan filtering unit (FFU) to address the new guidelines with a solution that improves ventilation and draws less than 2 amps of power to operate. (This would equate to powering an additional laptop computer in a building.)

Implementing an FFU, which is a motorized unit that supplies clean, filtered air to a space, is a more frequently adopted approach in modern cleanroom designs. The key is reaching the air change rate goal, and then disinfecting the contaminants through the filtration system, ultimately creating a mini cleanroom within any commercial space.

Cleanroom design requires strict compliance of having less than 35,200,000 particles at >0.5 micron per cubic meter and 20 HEPA filtered air changes per hour.[7] By comparison, a typical office space or classroom is 5 to 10 times dirtier, so to design a best-in-class solution, the engineering team designed the technology to decouple filtration and air changes from the HVAC infrastructure and ventilation to create a microenvironment.

It works by drawing air via the fan through a pre-filter, and then circulates it through the HEPA filter to capture sub-micron particles and then clean and process the air supply. The sweeping of the air via the FFU localizes and cleans the air in a more energy-efficient route than using a traditional Air Handling Unit. The unit is installed in a central location and circulates air using a short, streamlined airflow, avoiding horizontal streamlines so there are no dead spots in the space. The technology integrates with the HVAC control system to maintain proper temperature and humidity levels needed for each environment.



A Cost-Effective Solution to Address Indoor Air Quality

The microenvironment approach provides an additional 4 to 10 ACH within each room that integrates the FFU. The sub-micron filtration captures particles, exceeding the HEPA standard of 99.97% at 0.3 micron. Because the energy-efficient solution requires less than 115 Volt/1 Ph, it's quiet and compliant with NC35. It was designed to work in conjunction with any existing HVAC system and is compatible with drop or hard ceilings. The best-in-class technology provides optimal airflow patterns to create vertical streamlines with high supply and low returns.

THE RESULTS

Stark Tech implemented the design at 6 beta sites, installing test units in mostly classroom settings to prove out the technology and the concept against ASHRAE 52.2 Test for Efficiency and Resistance for the FFU design. Through third-party validation by Blue Heaven Technologies, each beta site showed 100% efficacy down to 0.3 micron, drawing less than 1 amp of power.

To test and prove the hypothesis, the cleanroom testing agency took baseline particle counts within the classroom, and then introduced aerosol, or fog, into the room to simulate an active classroom. The test measured and recorded how fast and effective the existing infrastructure could remove the particulates against the microenvironment approach, which was then measured and recorded, simulating the concept of 6.5 ACH.

Stark Tech and Healthway expected to show a 100% capture rate at the following submicron levels:

- 0.30 – 1.0 um
- 1.0 – 3.0 um
- 3.0 – 10.0 um

Test conditions measured:

- Barometric Pressure (In. Hg.) at 29.43
- Air temperature at 69F
- RH at 39%
- Airflow Rate at 650 CFM
- Nominal face velocity at 234 fpm
- Initial resistance at 0.28 WG

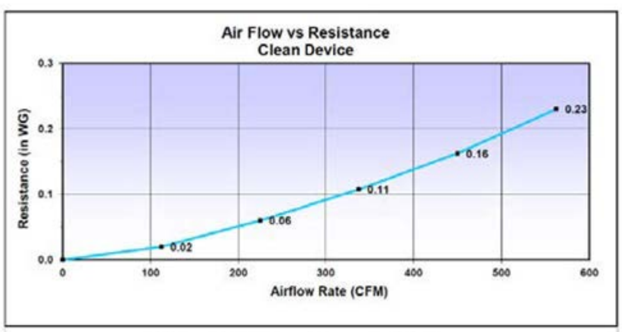
The parameters of the test conditions were designed to evaluate air flow, air pressure, and air filtration.

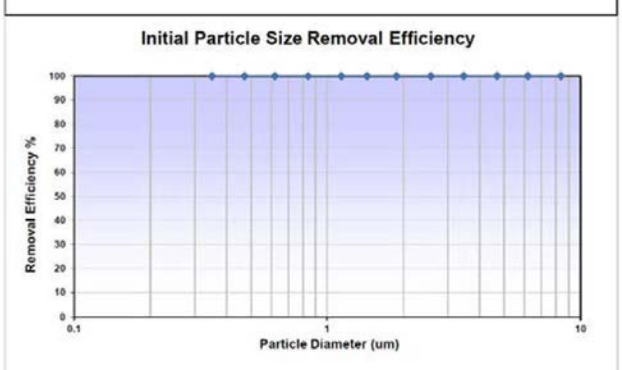
Data at the initial resistance level tested:

Airflow (CFM)	Resistance (WG)
0	0.0
113	0.02
225	0.06
338	0.11
450	0.16
563	0.23

PARTICULATE REMOVAL EFFICIENCY

Particulate Size (um)	Geometric Mean Diameter (um)	Initial Removal Efficiency (%)
0.03-0.04	0.35	100.0
0.40-0.55	0.47	100.0
0.55-0.70	0.62	100.0
0.70-1.00	0.84	100.0
1.00-1.30	1.14	100.0
1.30-1.60	1.44	100.0
1.60-2.20	1.88	100.0
2.20-3.00	2.57	100.0
3.00-4.00	3.46	100.0
4.00-5.50	4.69	100.0
5.50-7.00	6.20	100.0
7.00-10.00	8.37	100.0





The testing conditions measured air flow rate at 450 CFM and results indicated that the solution was highly effective at maintaining the recommended air changes per hour and filtered out the aerosol particulates down to less than 0.03 micron.

In testing environments at 650 CFM, results also showed 100% removal of particles at 0.03um.

Airflow (CFM)	Resistance (WG)
0	**0.00**
163	**0.03**
325	**0.10**
488	**0.18**
650	**0.28**
813	**0.40**

PARTICULATE REMOVAL EFFICIENCY

Particulate Size (um)	Geometric Mean Diameter (um)	Initial Removal Efficiency (%)
0.03-0.04	0.35	100.0
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0.55-0.70	0.62	100.0
0.70-1.00	0.84	100.0
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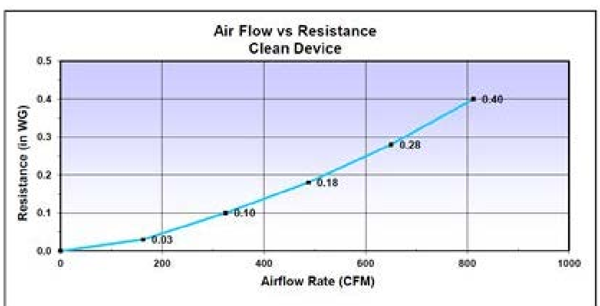

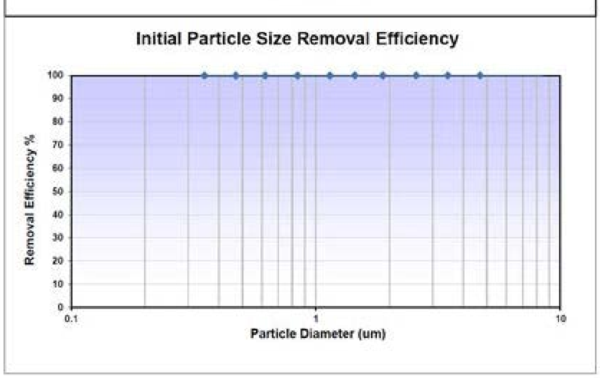

CONCLUSION

The pandemic has pushed organizations, companies, and school districts to scrutinize indoor air quality more closely. But indoor air quality is an issue that goes beyond the pandemic. Studies show that there's a direct correlation to lower test scores and lower productivity in workspaces with poor indoor air quality. The empirical data shows commercial spaces on average are drastically under designed to provide good indoor air quality. One main issue is that ventilation systems were not designed to recirculate and sweep the air at the rate needed to prevent the spread of contagious viruses and other airborne pathogens like dust and pollen.

The current infrastructure in buildings provide the bare minimum of ventilated air into spaces, the bare minimum of filtration, and the bare minimum of air exchange rates needed to turn over the air in the room in an efficient and circular pattern. Add to that the fact that most people spend up to 87% of time indoors, and building owners have a rough road ahead to provide quality indoor air within these spaces without proper technology.

In the end, what matters is that the data supports the marketing. The beta testing performed by Blue Heaven Technologies supports Stark Tech and Healthway's position that the FFU technology developed to create microenvironments is a best-in-class solution that addresses indoor air quality concerns in an economic and energy efficient way.

BETA SITE TESTING: FAIRPORT CENTRAL SCHOOL DISTRICT | FAIRPORT, NY

According to the U.S. Census Bureau, the average cost that a school system spends per pupil is roughly $24,000 in New York, for example. In a typical 600 to 1,000 square foot classroom, a microenvironment can be implemented in less than half the cost of one student. It includes the installation, which takes less than one day, the equipment, controls, ductwork, and installation.

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