VENTILATE AND OPEN AMERICA

The Imperative of Converting from Mixed Ventilation to Directional Ventilation

Attached is a Power Point type presentation that describes the type of ventilation system used throughout the United States in the places where you work, shop, play, and congregate.

My purpose for sharing this information is to raise your awareness about indoor ventilation practices and how they affect your well-being. The most ubiquitous indoor ventilation system in the USA is the Mixed Ventilation (MV) system. These systems are designed to mix the air in the space and to provide comfortable levels of temperature and humidity across the space. The danger posed by MV systems is that they perform their function so well. They distribute air and suspended pollutants uniformly across the space very quickly.

In an occupied space, a steady level of exhaled aerosol particles is reached after a few minutes that is based on the number of occupants and their activity level. During normal times, i.e., pre-pandemic, sharing these suspended particles. i.e., inhaling them, could transmit infectious diseases such as the well-known seasonal cold and flu. Even with masking, distancing, barriers, and sanitation efforts, we live and work in an aerosol cloud of exhaled particles that are spread across the space buy the ventilation system.

In 2021, the CDC published several Scientific Briefs that discussed mitigation strategies to reduce the spread of disease and lower risk of exposure to COVID-19 variants. The primary list included physical distancing, masking, sanitation, and improvements to building ventilation.

From CDC Scientific Brief: SARS-CoV-2 Transmission, Summary of Recent Changes May 7, 2021, [1]

- *This science brief has been updated to reflect current knowledge about SARS-CoV-2 transmission and reformatted to be more concise.*

- *Modes of SARS-CoV-2 transmission are now categorized as inhalation of virus, deposition of virus on exposed mucous membranes, and touching mucous membranes with soiled hands contaminated with virus.* ***[2]***

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• *Although how we understand transmission occurs has shifted, the ways to prevent infection with this virus have not. All prevention measures that CDC recommends remain effective for these forms of transmission.*

There is a consensus that improvements to building ventilation are required to reduce exposure to disease agents moving with the air. The problem is that to date no one is making the correct improvements to effectively reduce exposure. In fact, some of the mitigation strategies make indoor spaces more dangerous relative to inhalation hazards.

The following extract is from the CDC that provided further guidance relative to reducing hazards in indoor spaces by making changes to existing ventilation. In the list of recommendation to improve ventilation, most of the items have little effect and some increase the rate at which hazardous particles are spread across the space. There was only one sensible recommendation that could potentially eliminate the spread of infected exhaled aerosols in indoor spaces – Directional Ventilation. That is, an air flow pattern that flows from clean-to-less clean and then to exhaust as stated below. DV systems are an option to MV systems but are not common in the US.

CDC Update as of June 2, 2021

Ventilation in Buildings [3] - **Summary of Recent Changes**

• *Generate clean-to-less-clean air movement by evaluating and repositioning as necessary, the supply louvers, exhaust air grilles, and/or damper settings.* ***[4]***

Mixed Ventilation (MV) Systems Promote the Spread of Airborne Hazards

In the attached power point presentation, 'Ventilate and Open America' I describe critical issues related to the ubiquitous MV system and why it is dangerous relative to spread of airborne diseases, specifically COVID-19, its variants and seasonal influenza. MV systems typically have ceiling mounted supply diffusers that direct air along the ceiling. When moving air approaches a wall it begins to flow down into the room that creates multiple recirculation zones in the space. Pollutants generated in the room, such as exhaled aerosols, are entrained and spread around the room in the recirculation zones. MV systems

strive to mix air in the room to ensure uniform temperature and humidity across the space as determined by supply and return grill locations.

The attached V&OA presentation references a computer model of a classroom type space that I ran in 2020 that demonstrates the movement of small particles (aerosols) throughout the space. It shows that indoor spaces with mechanical ventilation of the MV type have uniformly distributed particles shortly after the space becomes occupied. Further, it shows that purging the space takes many minutes to hours depending on the air change rate (ACH).

The Perfect Storm

One of the best methods for spreading hazardous aerosols/gases around an enclosed space would be to install an MV system. The addition of ceiling fans and/or standalone floor filters would also increase mixing. Masking in indoor spaces with MV systems provides little benefit considering efficiency values for typical cloth and surgical masks.**[5] [6]** There is a world of difference between these types of masks and a properly fitted N95 mask, by about a factor of 4x. The addition of plexiglass barriers is another ineffective measure as air currents flow up, over, and around them in a room with MV. They would provide some protection from a person coughing or sneezing towards another person, such as a clerk but not over the long term in a room with MV.

I believe that the CDC has failed to bring about a public awareness of how the virus is spread – i.e., AIRBORNE as indicated above. Many people continue to believe direct contact with formites is the main route, thus the continued deep cleaning and scrubbing. HVAC experts and facilities managers believe that 100% fresh air and high air change rates make the spaces safer, which is incorrect. The CDC and OSHA have both failed to explain masking and barrier effectiveness and consequently people have a false sense of security (protection) related to these measures.

Recommendations

- Review the attached V&OA summary for background information and a link to a computer model of a classroom type space that shows how aerosols are spread in a rapid fashion in spaces with Mixed Ventilation.

- Familiarize yourself with the latest ASHRAE, CDC, and OSHA publications related to airborne hazards, many of which I have referenced here and on my Drennen Engineering website.

- Begin a discussion with your colleagues about mitigation strategy that coincide with recommendations from the referenced agencies and organizations as indicated above and in the attached presentation, specifically related to changes in ventilation practices.

- Consult with internal flow experts on solutions to increase indoor ventilation efficiency. HVAC professionals, like you, are not familiar with the directional-ventilation recommendations and the resulting benefits, if they were, you would be reading their analyses and recommendations.

- Make no assumptions about the level of effort required to change an existing MV system to a DV system. To get a better understanding of DV, see the computer model video of a doctor's exam room on the Drennen Engineering website. This shows a CoVentilation™ system that is a variation of a typical DV system.

I am available to discuss these concepts and possible remedial actions you can take free of charge. My mission is to bring about a higher level of awareness to the public and people in a position to promote changes in ventilation practices that will reduce indoor inhalation hazards. My hope is that when people are asked for proof of vaccination, they will counter with a request for proof of ventilation.

If you are interested in hosting a demonstration project in a space under your supervision, a business, office, or classroom, please let me know. The purpose would be to show current Mixed Ventilation flow patterns in the space and demonstrate how they can be improved with a change to Directional Ventilation, such as the CoVentilation™ arrangement by Drennen Engineering, Inc. A successful strategy for making indoor spaces safer would reduce the possibility of inhaling someone else's infected

spittle. Changing to a ventilation system that moves air from clean-to-less clean to exhaust would provide a significantly safer environment. It's that simple.

Final Thought

CT has received over a billion dollars of federal funding to address COVID-19 related issues. Each CT town received a piece of that pie with each splitting that piece between town and school budgets. The schools will have allocated some of that slice to ventilation system improvements, no doubt in the hundreds of thousands of dollars range. Has anyone heard of any town officials bragging how they have made town spaces safer by following CDC guidelines for directional ventilation? Makes me wonder what they have done/are doing with those dollars that has or will make the spaces safer.

REFERENCES

[1] https://www.cdc.gov/coronavirus/2019-ncov/science/science-briefs/sars-cov-2-transmission.html

[2] Dr. Rochelle Walensky, CDC director has publicly stated that infection due to contact with contaminated surfaces is quite low and she and other scientists recognize that the virus is spread primarily through the air. *https://www.cdc.gov/coronavirus/2019-ncov/more/science-and-research/surface-transmission.html*>

[3] https://www.cdc.gov/coronavirus/2019-ncov/community/ventilation.html#daf

[4] An example of a directional ventilation system can be seen on my Drennen Engineering website at the following location: https://drennenengineering.com/airborne-particles/

[5] Cloth and surgical masks have filtration efficiencies of 10 & 12% respectively, it they are worn properly. See, Experimental investigation of indoor aerosol dispersion and accumulation in the context of COVID-19: Effects of masks and ventilation, Physics of Fluids 33, 073315 (2021); https://doi.org/10.1063/5.0057100 (Yash Shah, John W. Kurelek, Sean D. Peterson, and Serhiy Yarusevycha)

[6] 'Surgical masks are not designed or certified to prevent the inhalation of small airborne contaminants.' [Published 05/2009] https://www.osha.gov/sites/default/files/publications/OSHA3219.pdf

Unprompted questions to help evaluate ventilation awareness:

1. **Q - What is the primary route of transmission of the COVID virus and its variants?**
   A – Per CDC, inhalation of infectious particles is the primary means with a decreasing emphasis on transmission by formite contact and airborne droplets.

2. **Q – What makes a variant more transmissible?**
   I don't have an answer for this question, and I have not heard an explanation from anyone that I have heard utter this phrase, so I will speculate:
   A – More infectious particles being exhaled? Quantity and quality.
   A – Shorter exposure time to infection?
   A – Fewer particles needed to infect?

3. **Q – What ventilation improvements can be made in indoor spaces to make them safer (relative to suspended infectious aerosols)?**
   Everyone talks about improvements, but few know what it requires.

   A – Natural Ventilation with windows and doors open. Promotes movement of clean air across space, however while this is an improvement for enclosed spaces with MV, it is not a reliable method and is useful only during temperate weather.

   > *FYI - Increasing air flow into a space with MV increases the rate at which suspended pollutants are spread across the space, even if the intention is to dilute the pollutants, such as with Dilution Ventilation. Changes that promote mixing increases exposure.*

   A – Directional ventilation establishes a frow pattern from clean air supply towards less-clean areas such as occupied zones and then to the exhaust, with minimal mixing, and consequently reduced recirculation of contaminated air.