Anatomy of a Heathy School

An HVAC Primer for Safety, Comfort, and Productivity

Introduction

While the primary method of COVID-19 transmission is in droplet form—i.e., person-to-person or via surfaces, researchers are still studying the virus, given its relatively brief stint thus far on the world stage. Researchers have not definitively determined that the virus can be transmitted through the air, but the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) has asserted that, "Transmission of SARS-CoV-2 through the air is sufficiently likely that airborne exposure to the virus should be controlled."

So, while hand-washing with warm water and plenty of soap, along with and surface-sanitizing and avoidance of close person-to-person contact are still the main methods to stay healthy, there are several other steps that building engineers can take to significantly minimize the risk of transmission.

What that Means for Schools

A school should be a safe place – for students, teachers, staff, and visitors. Studies have increasingly shown that air quality and noise levels are key factors in the ability of students to maximize their learning potential – and that was before the COVID situation in which we find ourselves today. America's heating, ventilation, and air conditioning (HVAC) equipment manufacturers are committed to providing the technologies that can make schools – and all public buildings – as safe and health-affirming as they can be.

There obviously are many factors that influence the relatively health of a school building, but for the purposes of this paper, we will focus on optimizing a school's HVAC system.

A Healthier School Begins with a Qualified Contractor

A well-designed, modern HVAC system, properly installed and maintained, will ensure comfort and productivity while ensuring and enhancing health and safety. Each system component is designed to work in concert with the others to optimize all those attributes. In the current situation, where health and safety must be emphasized, there are several technologies that should be employed to accomplish those objectives.

According to ASHRAE, school building officials should consider retaining the services of a qualified design professional, a certified commissioning provider (CxP), or a certified testing, adjusting and balancing (TAB) service provider especially for larger, more complex HVAC systems, such as those found in school buildings or for systems serving critical spaces within buildings. Furthermore, school officials should seek contractors that employ technicians certified by North American Technician Excellence (NATE) to have been highly trained, tested, and found proficient in one or more of eleven HVACR-related specialties. Such contractors can be found at www.natex.org.

Ventilation is Key

There has been considerable media coverage of a limited study conducted in China last April in which it was alleged that

restaurant patrons had contracted COVID-19 through airborne transmission due to a wall-mounted air conditioning unit. Leaving aside whether the study's findings were correct, with respect to the air conditioner in question (there were several other possible contamination routes), its main drawback was lack of ventilation. This particular unit did not provide any outdoor air at all, but instead recirculated the air within the restaurant.

Although it might seem counterintuitive to *increase* the flow of air that could be moving viral particles around, moving *more* air and providing more outdoor air is beneficial because of pathogen dispersal. In fact, the CDC's Interim Guidance for Businesses and Employers to Plan and Respond to Coronavirus Disease (COVID-19) specifically advises to "Increase ventilation rates" and "Increase percentage of outdoor air."

In a recent New York Times op-ed, Dr. Joseph Allen, Director of the Healthy Buildings program at Harvard University's T.H. Chan School of Public Health, extolled the benefits of adequate building ventilation in helping to stem the spread of disease. "…bringing in more outdoor air in buildings with heating and ventilation systems (or opening windows in buildings that don't) helps dilute airborne contaminants, making infection less likely. For years, we have been doing the opposite: sealing our windows shut and recirculating air." He further quoted a 2019 study in the journal *Nature* that found that even minimum levels of outdoor air ventilation could reduce transmission of the flu to an extent normally associated with a 50- to 60-percent vaccination rate.

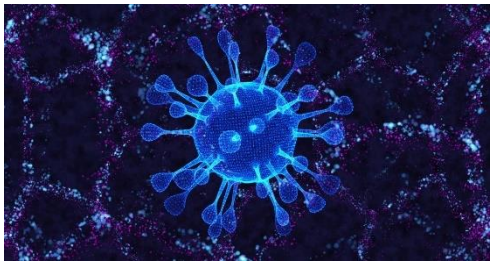
Filtration is a Must

Building engineers are encouraged to improve the efficiency of the filters serving their HVAC systems within the guidance provided for most of the building types listed on the ASHRAE COVID-19 Preparedness Resources website. Mechanical filters are the most common types of filters found in HVAC systems. The term used to describe mechanical filter efficiency is MERV, which is an acronym for Minimum Efficiency Reporting Value. The higher the MERV number, the better the ability of a filter to remove particles from the air.

ASHRAE recommends that mechanical filter efficiency be at least MERV 13 and preferably MERV 14 or better to help mitigate the transmission of infectious aerosols. Many existing HVAC systems were designed and installed to operate using MERV 6 to MERV 8 filters. While MERV 13 and greater filters are better at removing particles in the 0.3 micron to 1 micron diameter size (the size of many virus particles) the higher efficiency does not come without a penalty. Higher efficiency filters require greater air pressures to drive or force air through the filter. Care must be taken when increasing the filter efficiency in an HVAC system to verify that the capacity of the HVAC system is sufficient to accommodate the better filters without adversely affecting the system's ability to maintain the building's required indoor temperature and humidity conditions and space pressure relationships. A qualified HVAC technician has the tools to determine the maximum possible MERV filter for an individual system.

UV Light Treatment Should be Considered

In a May 7 New York Times article, researchers discussed the use of ultraviolet light in combating infectious pathogens. "We have struggled in the past to see this highly effective, very safe technology fully implemented for airborne infections," said Dr. Edward A. Nardell, a professor of global health and social medicine at Harvard Medical School. "We've done the studies. We know it



works."

The article notes that UV light "mangles the genetic material in pathogens — DNA in bacteria and fungi, RNA in viruses — preventing them from reproducing." "You've killed it essentially," said William P. Bahnfleth, a professor of architectural engineering at Pennsylvania State University.

In a March 9 article in the HVAC trade publication *ACHRNews,* industry experts noted that ultraviolet (UV) light treatment can complement filtration by addressing the particles that can slip through filters. "UV germicidal systems have also been shown to reduce microbial load and pathogens that are found within the HVAC system and drain pan that would otherwise be introduced and distributed throughout the envelope of the building," the article quoted Aaron Engel of indoor air quality equipment manufacturer Fresh-Aire UV as saying. UV treatment systems can be used in homes and commercial buildings.

His opinion was seconded by Bahnfleth, who noted that, "Even HEPA filters that have been tested in the laboratory with viruses will have some level of penetration…not much — a few percent. But if anything gets through and if it's a very virulent pathogen, that means you're not perfectly protected against infection by that filter." Hence the complementary UV system to catch those that slip through.

As noted above, UV light treatment can be used as a supplement to filtration, killing pathogens that escape. Daniel Jones, president of UV Resources, a UV light treatment equipment company, touted upper-air UV-C fixtures as a commercial building remedy for viral droplets: Airborne droplets containing infectious agents can remain in room air for six minutes and longer," he said. "Scientists have found that COVID-19 can remain infectious on surfaces at room temperature for up to nine days. Upper-air UV-C fixtures can destroy those microbes when they are exposed to the UV-C energy in a matter of seconds." He pointed to kill ratios of up to 99.9 percent on a first-pass basis that have been modeled, and concentrations are further reduced each time the air circulates.

Humidity Control is Also Important

Viruses are least viable in buildings with humidity between 40- and 60-percent. Schools in cooler climates are susceptible to humidity levels lower than optimal, making humidifiers a necessity.

The Bottom Line

Schools should prioritize building assessment, through which qualified technicians conduct tests and assessments to determine a) appropriate air flows, and b) if spaces within the building (particularly classrooms, offices, and large spaces such as auditoriums and gymnasiums) are achieving those air flows.

It should be well understood that a healthy building, whether a school, office building, public space, or even a home involves tradeoffs of energy use, comfort, and safety. Some of the remedies advocated above can increase energy usage, but with health being a top priority, particularly in the time of pandemic, most will find that the resulting increase in comfort and safety necessary and worthwhile.

A properly installed, properly maintained system, with adequate ventilation using outside air, proper filtration, and appropriate humidity control – all of which are accomplished through readily available technologies -- can go a long way toward mitigating potential viral spread.

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