AIR CONDITIONING AND COVID-19: SLOWING THE SPREAD

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The Story of COVID-19 and Air Conditioning

A generation of research and experience has proven that when properly maintained and operated, heating, ventilation and air-conditioning systems (HVAC) can reduce the spread of viruses. These critical building systems not only provide thermal comfort but, according to the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), may also improve resistance to infection.[1]

The American Society for Microbiology (ASM) has recently addressed the issue of COVID-19 transmission in the "built environment" (BE), defined as the buildings, automobiles and other indoor settings in which most humans spend more than 90 percent of their daily lives.[2] There are several major transmission vectors that promote infection in these built environments, the report says, including occupant density, the amount of social activity and interaction, and human contact with abiotic surfaces. The cruise ship industry, nursing homes and prisons have taught us about the risk of transmission from settings where these vectors intersect. However, we also have learned that proper hand-washing and social distancing work to reduce transmission.

Alongside these primary mitigants, HVAC systems work in a built environment to supply comfortable, clean, recaptured air, mix in healthy levels of fresh air, and contain or exhaust contaminants. Air delivery systems can reduce the transmission of viruses through inline filtration, something HVAC professionals are capable of assessing.

Air-conditioning systems are also critical in maintaining healthy humidity levels. "Maintaining a RH (relative humidity) between 40% and 60% indoors may help to limit the spread and survival of SARS-CoV-2 within the BE," the ASM suggests, "while minimizing the risk of mold growth and maintaining hydrated and intact mucosal barriers of human occupants."[3]

The Centers for Disease Control (CDC) echoes these findings, saying that employers can decrease the spread of COVID-19 by maintaining a healthy work environment. "Consider improving and engineering controls using the building ventilation system," the CDC suggests, including increased ventilation rates and increased percentage of outdoor air circulating through the system.[4]

Well before COVID-19, the Healthy Building Movement had begun to measure and improve air quality in the built environment to improve productivity and health. Of the nine foundations for a healthy building, five relate to HVAC, including air quality, ventilation, thermal health, moisture, dust and pests. "There's just no reason anymore to economize on airflow and filtration," Harvard Business School's John Macomber says. "It's a cheap way to help people be healthier."[5]

A Restaurant Story

Modern, professionally maintained air conditioning can play a positive role in the control of COVID-19 by ensuring a healthy built environment during and after the pandemic. But news reports about an incident in a restaurant in China have attributed the spread of the virus to the restaurant's air-conditioning system. Technically, none of this reporting was incorrect, but a careful look at the underlying details reveals a very different story.

By February 10, 2020, 10 people from three families who had eaten at the same air-conditioned restaurant in Guangzhou were infected with COVID-19. Researchers at the Guangzhou Center for Disease Control and Prevention believe that the virus was transmitted from an asymptomatic 63-year-old woman in one family to at least one member of each of two nearby families seated at neighboring tables about 1 meter apart. Because immunologists are confident that COVID-19 can be transmitted via large infected droplets caused by talking, sneezing or coughing, the researchers believe that this diner's infected droplets — normally heavy enough to fall to the floor before reaching a table 1 meter away — were boosted by airflow from the restaurant's air conditioning.

Seventy-three other restaurant customers were identified as having close contact with members of those three families, but none developed COVID-19 symptoms. Neither did the eight restaurant workers serving those guests.

Six smear samples from the air conditioner's air outlet and air inlet also tested negative for the virus.

In other words, the restaurant's air-conditioning system was virus-free and operating as intended. "The key factor was the direction of the airflow," researchers surmised.[6]

Proper airflow management is essential. Without knowing all the details in this case, it is likely that improper air distribution, combined with a lack of social distancing, may have contributed to the transmission in this restaurant. It is important to manage airflow and airflow velocity in an occupied space. Research and ASHRAE guidelines point to an upper limit of air velocity in an occupied space of 40 fpm. To achieve this condition, the air needs to be properly blown by the HVAC system into the room, and properly distributed in the occupied space. It is unclear if the restaurant in this case met these criteria, but, based on the researchers' conclusions, it appears unlikely.

"To prevent spread of COVID-19 in restaurants," the report concludes, "we recommend strengthening temperature-monitoring surveillance, increasing the distance between tables, and improving ventilation."[7]

Nowhere in the report is there any suggestion of turning off the air conditioning as a mitigating action.

HVAC Best Practices

As previously mentioned, HVAC systems and the built environment can play an important role in preventing the spread of viruses. To ensure the proper indoor air purity, a good HVAC system should include some or all of the following:

1. **(Demand Controlled) Ventilation:** When outside air is not provided via separate devices, the HVAC system should provide outside air based on the size/use of the space. Where possible, the HVAC system should include a sensor for carbon dioxide or other pollutants to calculate and correct in real time the amount of ventilation needed. It is important to be aware that the increase of the ventilation rate may cause an increase of load, and the HVAC unit, if not properly sized, may not be able to provide sufficient cooling capacity. In such situations, it may be appropriate to consider Direct Outdoor Air Supply (DOAS) units, which are specifically designed for large amounts of outside air.

2. **Filtration:** Filters are rated on their ability to capture and retain particles of different sizes. The industry standard is a Minimum Efficiency Reporting Value (MERV) rating. Filters with MERV >13 have a significant ability to capture particulate matter (PM) and smaller particles. HEPA filters are even more efficient and are able to capture bacteria and viruses. Note that there are important tradeoffs to consider: the higher the filtration requirements, the greater the air pressure drop and the size of the filter. For this reason, the air management system of the HVAC needs to be carefully sized based on the filtration requirements.

3. **Other Indoor Air Quality Devices:** Numerous technologies are available to reduce the presence of contaminants. Ultraviolet lights, ultraviolet photocatalytic oxidation, ionization, plasma, electrostatic active, active carbon and other components can be installed to specifically target volatile organic compounds (VOC), bacteria and viruses. Some of these options can be available as integral parts of the HVAC system.

Air Distribution:

1. The airflow rate, air velocity and direction of the air discharged by the air-conditioning unit need to be carefully controlled. The goal is to have uniform distribution of temperature in the room and to avoid air velocities above 40 fpm in the occupied space, thus avoiding draft and risk of carrying particles from one part of the room to the other.

2. The total amount of airflow needs to be properly calibrated to the cooling capacity of the unit (a best practice in North America of 200-400 cfm/ton is often quoted). In addition, the cooling capacity of the unit should not be oversized or undersized compared with the cooling load of the space.

3. The location of the air outlet, the orientation of the air and the intensity of the air velocity at the discharge tend to determine the airflow in the room and need to be optimized. The more the air is blown directly to an occupied area, the more we will have a "spot cooling" effect and the worse the air distribution will be. On the other hand, an ideal distribution is achieved by: (1) locating the air outlet in a position that ensures good airflow, but does not directly blow air into the occupied space; (2) ensuring that air has the possibility to travel and expand before reaching the occupied space.

Air Conditioning Facts

Air conditioning is defined as the process of controlling temperature, humidity, purity and motion of air in an enclosed space. The main goal is to provide comfort to the occupants or needed precision temperature and humidity control.

In addition to comfort, good air conditioning improves health by reducing discomfort and thermal stress and associated susceptibility to viruses.[8] It is also proven that proper air conditioning in buildings increases productivity in schools and offices.[9]

In general, the primary parameters of indoor comfort/health are:

Temperature: It is the primary element of comfort. The ideal temperature (typically set using a thermostat) varies depending on numerous conditions (season, location, clothes, etc.). ASHRAE and CDC recommend[10] a range of 68.5-75 F in the winter, 75-80.5 F in the summer.

Humidity: Excessively high or low humidity leads to discomfort. A target range of 40%-60% relative humidity is normally used for comfort. ASHRAE recommends relative humidity below 60%.

Air Purity: In general, the presence of particulate, gases (carbon dioxide (CO_2), radon, volatile organic compounds), as well as viruses and bacteria cause poor air quality, with negative consequences for the occupants. Air conditioning helps improve air quality with various techniques, of which the most widely used are outdoor ventilation and filtration. ASHRAE prescribes specific ventilation rates depending on the application.[11] For instance, a conference room should see an outdoor ventilation rate of 15 cfm/person.

Air Velocity/Air Distribution: It is important that no sensation of draft (unwanted local cooling of the body caused by air movement) is caused by the air conditioning or other elements of air movement in the occupied space. Research and ASHRAE guidelines point to an upper limit of air velocity in the occupied space of 40 fpm.[12] To achieve this condition, the air needs to be properly blown by the HVAC system into the room, and properly distributed in the occupied space.

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