EBTRON INSIGHT: VENTILATION CONTROL FOR COVID-19 AND BEYOND

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ABSTRACT

- Outdoor air ventilation is essential to providing a healthy indoor environment.
- COVID-19 is putting new focus on ventilation design and operation of buildings.
- Control of ventilation above normal rates is necessary to
  - create a safe indoor environment
  - Protect building infrastructure.
- Safe and healthy buildings depend on
  - Dilution ventilation
  - Maintaining proper pressurization.
- When adequate ventilation is not provided, effects are not immediately known.
- Unless outdoor airflow is actively measured, determining under-ventilation may only come after it is too late to prevent the outcome.
- Weather and seasonal changes impact the ability to provide consistent ventilation.
- Proxy solutions, such as CO2 control, can provide an indication of ventilation but no definitive value.
- Controlling ventilation and exhaust is necessary to set building pressurization and to control indoor temperature and humidity.
- There are health, productivity, and increased property value benefits when creating a healthy indoor environment.
- In the case of combating a health crisis, monitoring and controlling ventilation is paramount.
- SARS-CoV-2 is recognized as an airborne virus through aerosolization.
- This has changed the dynamic from providing ventilation rates to minimize dissatisfaction with IAQ, to providing ventilation rates that dilute the concentration of virus particles in the air.
- This dilution through mechanical ventilation is recognized as the primary means of virus removal for all indoor environments.
- Monitoring and controlling actual flow rates in and out of the building is essential in ensuring dilution, pressurization, maximizing efficient operation of HVAC equipment, and creating a safe and healthy building.

BACKGROUND

- Building codes and standards specify minimum ventilation rates to provide acceptable IAQ.
- Achieving acceptable IAQ is when
  - 80% or more of the occupants do not express dissatisfaction
  - There are no significant known contaminant concentrations or an unusual source that would create a contaminant of concern.
  - Commercial buildings OA Ventilation designed in accordance with mechanical code prevailing for a local jurisdiction
    - International Mechanical Code (IMC)
    - Uniform Mechanical Code (UMC),
    - California Title 24 part 6 (T24)
    - ANSI/ASHRAE Standard 62.1 (62.1))

BACKGROUND

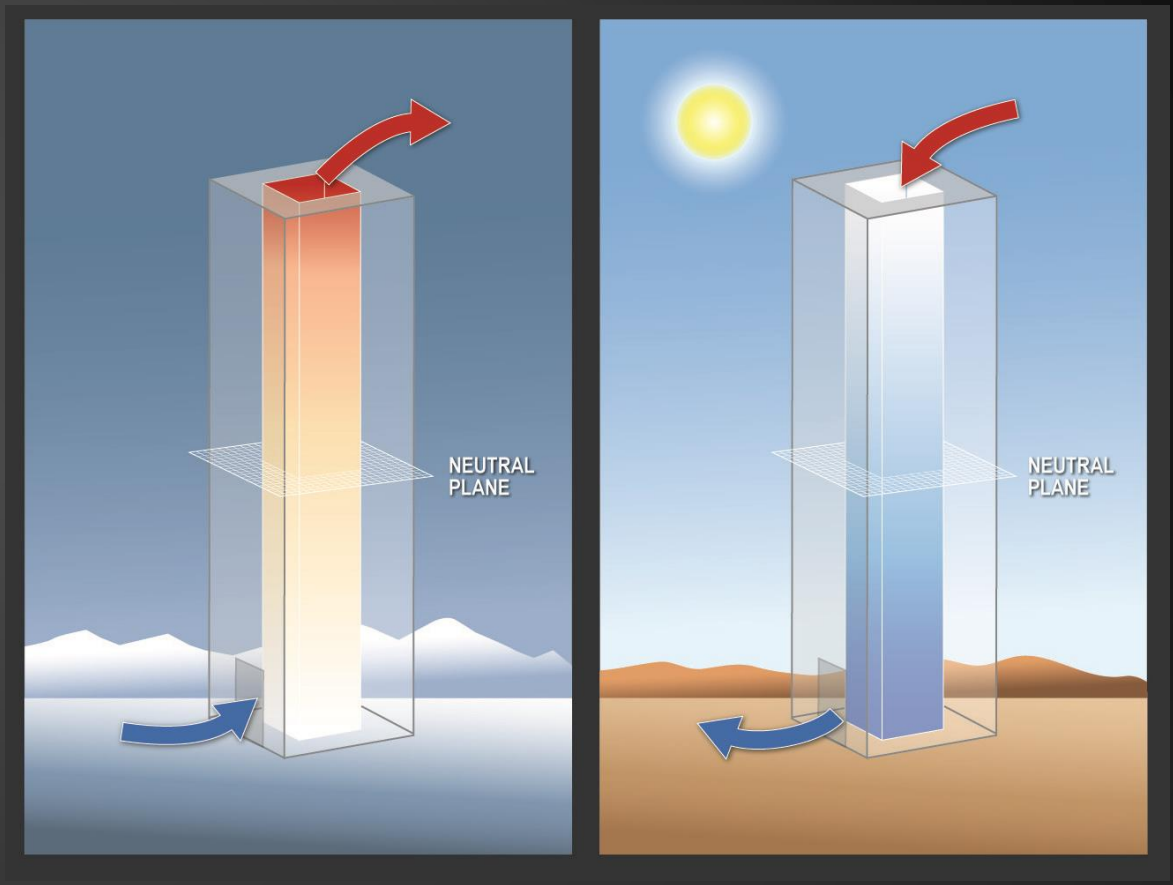
- The prescriptive ventilation rates within these codes are minimum requirements.
- Unless it is directly measured, a person cannot determine if the amount of ventilation air is the correct amount.
- There are delayed indications of inadequate ventilation that effect humans, such as headaches, fatigue, and upper respiratory irritations.
  - When this happens to a large percentage of building occupants, it is termed as sick building syndrome (SBS).
- When the ventilation setpoint is made, it is typically adjusted to deliver the ventilation rate designed for full occupancy at full flow with all zones proportionally balanced

BACKGROUND

- Section 5.1 and 5.3 of ASHRAE 62.1 requires:
  - Minimum ventilation airflow be maintained and delivered under any load condition or dynamic reset condition,
  - Provided with controls that maintain no less than the outdoor air intake flow as required by the prescriptive ventilation procedure
- The 62.1 Clarification:
  - *"To comply, most variable-air-volume (VAV) systems will need special design considerations and often features such as outdoor airflow sensors, modulating dampers and injection fans."* Further, *"A major consideration with VAV systems is that the negative pressure behind the outdoor air intake in the mixed air plenum will typically vary with supply air volume. At low supply airflow rates, this negative pressure will decrease, and sufficient outdoor airflow may not be maintained with a fixed outdoor air intake damper position—or even if a dedicated fixed minimum air intake is used."*

BACKGROUND

- Changes in weather and seasons impacts ventilation setpoints.
- Wind can hinder intakes or exhausts; the ventilation rate can be reduced by wind pressure.
- On systems without mixing plenums (e.g. exhaust, makeup air, Dedicated Outdoor Air Systems (DOAS)) the wind can add a pressure source in series with the fan that impacts operation on the fan curve.
- Stack pressure known as Stack Effect is due to density differences in the air.
- This density difference is caused by temperature differences between indoor and outdoor and creates a pressure difference that changes with seasons.

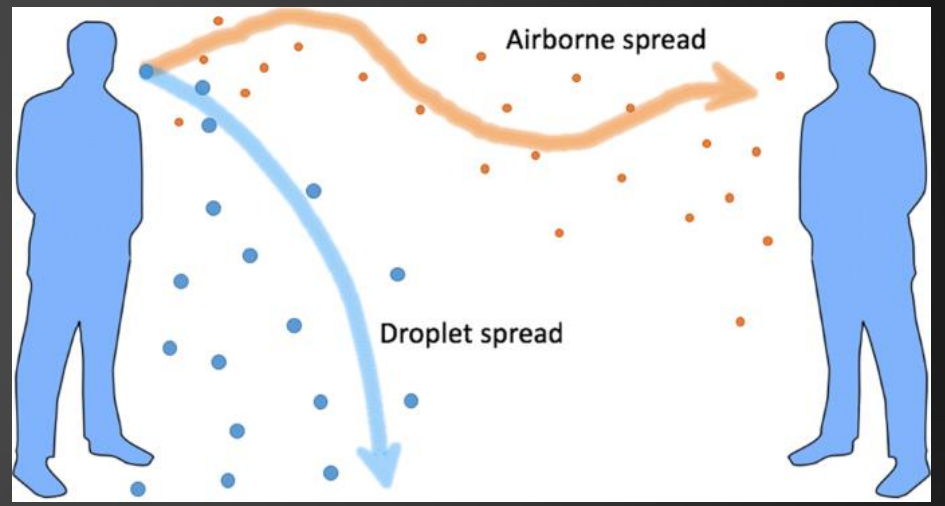


BACKGROUND

- It is important to understand all the components that make up the flow measurement device, such as
  - Measurement limitations
  - Potential drift
  - Any maintenance or calibration requirements associated with them (e.g. pressure transducers)
- It is best to use a measurement device that has been
  - factory calibrated for the application
  - is traceable to a national airflow measurement standard such as NIST.
- Products that have low density measurement or require set up based off field measurement carry additional error.

DISCUSSION

- Viruses have been identified as the most common cause of infectious disease acquired within the indoor environment.
- Airborne transmission can occur via direct contact with droplets, skin flakes and fungal spores
- Aerosols can be generated (atomized) during:
  - Breathing
  - Speech
  - Sneezing
  - Singing,
  - Vomiting,
  - Feces evacuation
  - Toilet flushing



- Aerosols can be as large as 100 µm (microns) in diameter and can exist in liquid or solid form with the majority of respiratory aerosols being less than 10 microns.
- A study has shown that individuals coughing while infected with influenza can release 75,000 respiratory droplets.
- The size distinction is important because larger droplets settle (fall to floor, furniture, clothing), and smaller ones remain suspended in air from minutes to hours.

DISCUSSION

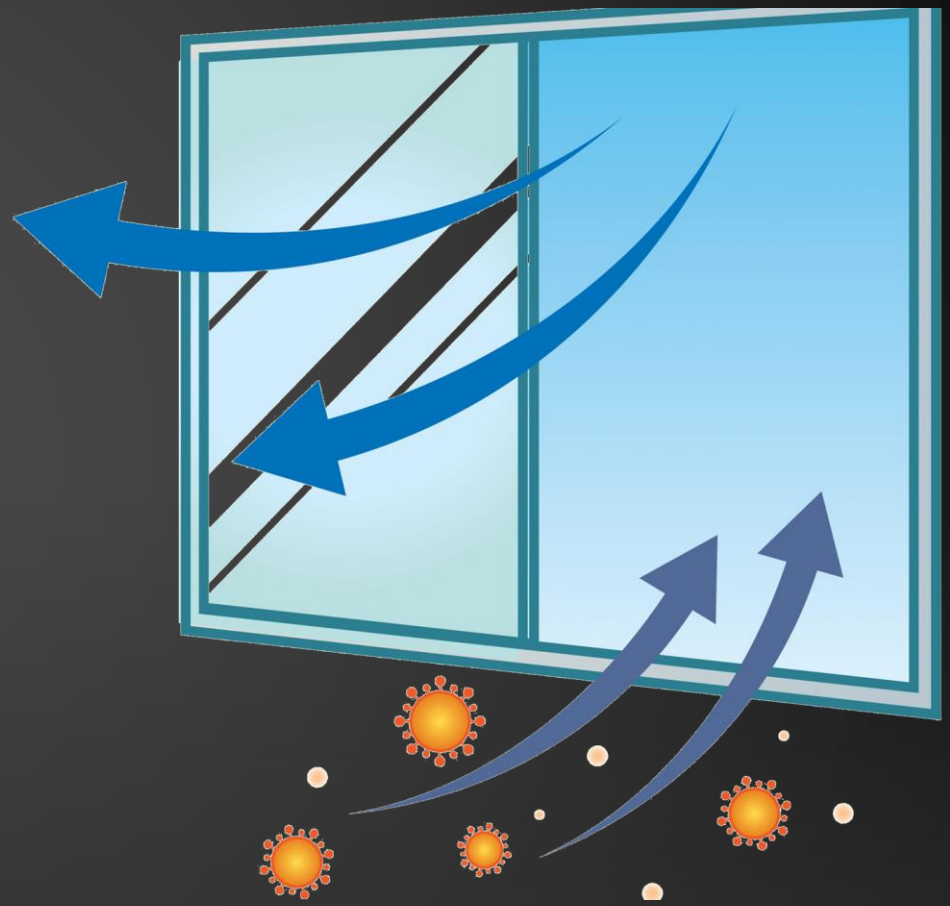
- The room environment impacts the survival of the virus and its ability to remain airborne.
- When a respiratory droplet is expelled, it is at 100% relative humidity (RH) and it decreases rapidly in size by evaporation into a room with a lower RH27,28.
- Those that remain in the air may eventually, become inactivated, settle out, or be diluted out by ventilation and exhaust29.
- What we know is that the infectious concentration in the air is dependent on the generation rate (Quanta) and the removal of the virus by settling, inactivation (decay rate), and ventilation29.
- The Quanta is influenced by how it is atomized, droplet size, temperature, and humidity.

DISCUSSION

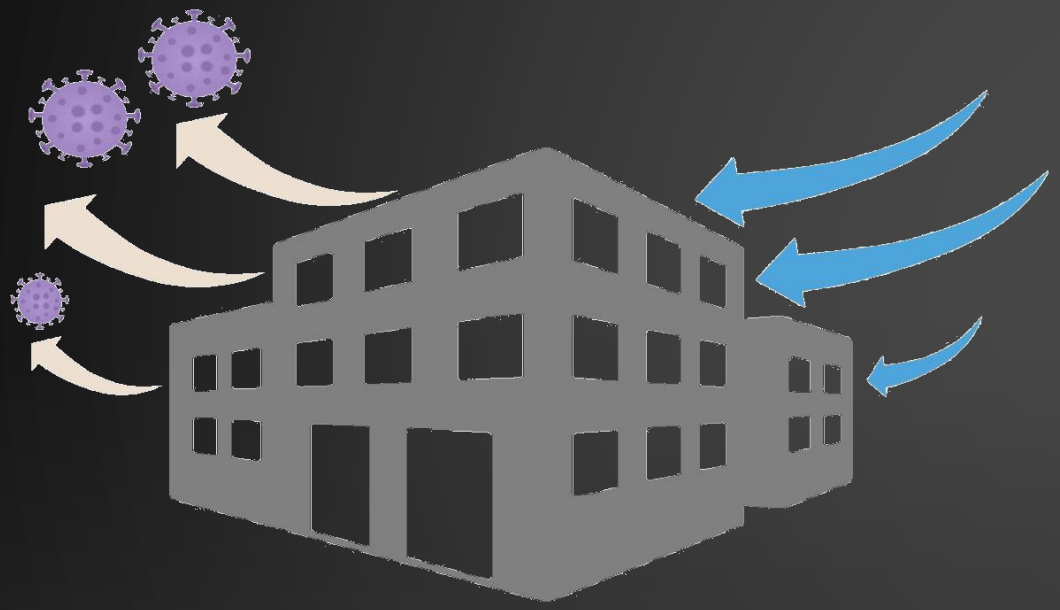
- **However, we can increase the decay rate and** strengthen the human response if we keep room RH between 40-60%. Viruses have more vitality, or less chance of inactivation, when the RH is > 90% or <40%27,29,32,33.
- The risk increases the more the individuals spend time indoors. In both pre and post lockdown calculations, mechanical ventilation significantly lowered the risk35. Ventilation, when implemented correctly as an engineering control, can have significant impact to providing a safe environment.
- Lack of ventilation control will create an environment that is at risk.

DISCUSSION

- Without adequate ventilation, the virus concentration will continue to climb and the recirculated air distribution within the indoor space can act as a super-spreader; infections go from close contact additive to sharing the same space exponential36,38.
- Air moving components (e.g. fans, dampers, louvers, ducts) and heat transfer equipment (e.g. hydronic coils, DX coils, energy wheels) are typically sized to convey and condition only the minimum ventilation requirements.
- The ability to add additional ventilation air may be limited while maintaining comfort and energy efficiency. However, the need to provide more dilution for a safer indoor environment should outweigh the penalties.
- DCV should be disabled during times that need enhanced dilution ventilation1.



DISCUSSION



- Maximizing economizing by increased high limits and using integrated economizer control strategies will increase dilution air.
- Resetting supply and space temperatures will also assist in providing more ventilation.
- In general, buildings should be kept slightly positive to neutral.
- In more complex buildings, flow maps should be created to determine interaction of systems and ensuring intended flow paths and pressurization flow. This is common for laboratories and hospitals and should be standard practice for all multiple zone buildings.
- The push for tighter buildings, demand control ventilation, and/or the use of air cleaning technologies to limit the outdoor ventilation rates handicaps buildings to maintain a healthy indoor environment.
- The focus is misdirected to building operating cost and ignoring the #1 asset, the occupant.

DISCUSSION

- Enhanced ventilation not only protects the people it also enhances their performance.
- Ensuring the correct amount of ventilation and exhaust is not only insurance, but an investment in health, productivity, and protection of the building and occupants41,42.
- What is needed can be achieved today with the correct planning and integration of airflow measurement and control into buildings.

CONCLUSION

- High sensor density airflow measuring devices should be incorporated at a minimum in outdoor air, supply air, return air, and exhaust air.
- Strong consideration should also be made to accurately measure flows to zones in DOAS and VAV systems43.
- Additional airflow measuring devices may be needed to combat wind and stack effect40.
- Avoid CO2 control as means to provide accurate and repeatable ventilation as it has drift, and is often misunderstood and applied. Make sure you select the correct airflow measurement device to suit the application17.

CONCLUSION

- Not only will real-time airflow measurement provide the rate of flow, this valuable data can be used to set upper and lower limits, maintain proper pressurization throughout operating conditions, perform ventilation load calculations, reset rates as conditions change, and initiate alarms.
- It essentially pays for itself by bringing value to the building and occupant productivity benefits41,42.
- Some building types such as schools, have significant research showing ventilation is a systemic problem that leads to respiratory health problems, absenteeism, developmental challenges, and building damage44.
- This is not the first airborne virus and it will not be the last. Act now, not only for today's challenges, also for the future

CONTACT THE EXPERTS

- Learn more about Ebtron's Airflow Measuring Solutions by going to http://www.technicalair.com/ebtrongoldseries
- Contact the Technical Air Systems' Sales Engineering Team at 973-285-0333 or by email at solutions@technicalair.com

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