Keeping Cool in the Time of Covid-19:

How to keep using air-conditioning to reduce the risk of infection while minimizing impacts to climate and energy demand

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Outlines

1. SARS-CoV-2, Definition and Transmission
2. HVAC Systems and Engineering Controls
3. ASHRAE Recommendations for Buildings
4. Energy versus Indoor Air Quality
MISSION
To serve humanity by advancing the arts and sciences of heating, ventilation, air conditioning, refrigeration and their allied fields.

VISION
A healthy and sustainable built environment for all.
ASHRAE OVERVIEW

- Founded in 1894
- 200+ Standards and Guidelines
- 56,000+ Volunteer Members
- 130+ countries
- 7,400+ Student Members
- 10+ Regions
- 190+ Chapters
- 400+ Student Branches
- 59 Active Research Projects Total of 907; $76 million
- Industry Classification:
  - Consulting Engineers
  - Contractors
  - Manufacturers
  - Manufacturing Representatives
  - Government, Health & Education
  - Design Build
  - Architects

www.ashrae.org
ASHRAE EPIDEMIC TASK FORCE

Formed to deploy ASHRAE’s technical resources to address current pandemic and future epidemics

- HVAC System Operation During Building Shutdown
- How to Return the HVAC System to Normal Operation
- Operating of Heating/Cooling System in Home
- Riding Mass Transit and Airlines
- Upgrading Filters and Use of Air Cleaners
- Healthcare Facilities, Commercial, Residential, Schools and Universities, Residential, Transportation

- Air Conditioning and Heating
- Ventilation Systems
- Exhaust Systems
- Filtration and Disinfection
- BAS and Access Control Systems
- Elevator Control
- Water Systems

www.ashrae.org/covid19
SARS-CoV-2, Definition and Transmission
Definitions

• COVID-19 is caused by the SARS-CoV-2 virus
• Virus consist of a lipid membrane with spike proteins on the surface, encapsulating RNA strands. Upon contact with human cells, the virus releases its RNA genetic material into the host cell, driving virus replication.
• Virus may require an incubation period of up to 14 days before the body exhibits any symptoms, if any.
• Average diameter 120 nm
• Total cases: 31-Million+
• Total Deaths: 970,000 +
• [https://www.worldometers.info/coronavirus/](https://www.worldometers.info/coronavirus/)
• Still in the First Wave of Infections
ASHRAE’s Positions on SARS-CoV-2

• Transmission of SARS-CoV-2 through the air is sufficiently likely that airborne exposure to the virus should be controlled. Changes to building operations, including the operation of HVAC can reduce airborne exposures.

• Ventilation and filtration provided by HVAC systems can reduce the airborne concentration of SARS-CoV-2 and risk of transmission through the air. Unconditioned spaces cause thermal stress to people that may be directly life threatening and lower resistance to infection. In general, disabling of HVAC systems is not a recommended measure to reduce the transmission of the virus.
Transmission of SARS-CoV-2

- It can spread from person-to-person:
  1. People in close contact
  2. Respiratory droplets via coughs, sneezes, etc.
  3. Touching surfaces of where the virus settled on
  4. Significant portion of people do not feel any symptoms, can act as virus carriers
Airborne Transmission

- Smaller aerosols from sneezes and coughs can last for significant time in the air depending on their sizes.
  - Large Droplets settle to the floor in a few seconds, usually drop within 1 to 2 m (3-6 ft) and can go longer distance at higher initial velocities.
  - Small Droplets (aerosols < 5 µm): Can last in the air for 1.5 hours (3 µm) to 41 hours (0.5 µm), can travel longer distance
- Those aerosols can spread throughout a room or household if the HVAC system is poorly designed or installed
- Consequently, cross-infections can occur
HVAC Systems and Engineering Controls
How to Improve the IAQ?

- Elimination
- Substitution
- Engineering Controls
- Administrative Controls
- PPE

Source: U.S. CDC&P, Hierarchy of prevention

Engineering Controls can be used to reduce infections through the HVAC system.
Engineering Controls

• Ventilation:
  • Outdoor Air dilutes indoor pollutants

• Filtration:
  • Trapping particles of different sizes depending on the filter efficiency

• Air Distribution:
  • A major factor in spreading contaminants or limiting their spread within a building

• Disinfection:
  • Can reduce indoor microorganisms by the installation of UVGI lighting

• Temperature and Humidity Controls (24°C and 40-60% RH)
  • Used to limit the growth of molds, and decrease microorganism's lifespan
Building Ventilation Rates

• Why not use 100% OA?
  ↑ Heating and cooling equipment size
  ↑ Energy consumed, excessive electric bills

• Minimums dictated by local code
  • Based on Standard 62.1 for commercial buildings
  • Based on Standard 62.2 for residential buildings

(Supersedes ANSI/ASHRAE Standard 62.1-2013)
Includes ANSI/ASHRAE addenda listed in Appendix K

Ventilation for Acceptable Indoor Air Quality
Filtration

• Filters can contribute to reducing indoor pollutants

• Filters with higher Minimum Efficiency Reporting Value (MERV) tend to remove finer particles

  MERV 5-8 filters
  Removes Coarse particles

  MERV 13-16 filters
  Removes fine and coarse particles at higher efficiencies
Filtration

- At higher MERV ratings, more particles can be removed
- Fractional efficiency is the percentage of particles of a certain size that would be stopped and retained by filter to the total particles.
- Particles will not be removed 100%
- Reduction of particles, reduces the risks of cross infections

Most Penetrating particle size through a filter usually between 0.1-0.3 µm
Filtration Bypass

• If filters were not adequately installed, then a portion of the supply air may bypass the filter
• The bypass usually occurs through gaps at the sides and corners of the ducting system
• More particle therefore can enter the room

<table>
<thead>
<tr>
<th>Filter original Type</th>
<th>Effective MERV with 1-mm gap</th>
<th>Effective MERV with 10-mm gap</th>
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Air Distribution

• Pressure Controls
  • Avoid the spread of pathogens from one room to the next
  • Study the stack effect within buildings

• Indoor air distributions:
  • Evaluate supply and return vent positions
  • Avoid horizontal air motion within indoor spaces
Building Stack Effects

➢ Stack effect: is the movement of air into and out of buildings from air buoyancy.

➢ In the winter: warmer air rises through the floors of the building, forces cold air to enter from the bottom floors.

➢ In the summer: the reverse process occurs, cooler air in the building precipitates, dropping to the bottom floors, cause suction of hot air from the top floors.
Building Stack Effect Solution

• Pressurization in the Lobby to reduce the stack effect.
  ➢ Exhaust systems is recommended to keep the home below the pressure in the corridor or hallway.
  ➢ This ensures that contaminant from one apartment would never enter another
  ➢ Open windows should be minimized to meet minimum ventilation requirements
  ➢ Placement of seals on windows and door to reduce infiltrations
Disinfection- UV Lighting

• Ultraviolet energy inactivates viral, bacterial, and fungal organisms.
• UV-C or UVGI is the most effective in inactivating germs, its wavelengths are between 100 – 280 nm, 265 nm is the optimum
• Can be installed, provided that safety measures are taken into considerations
• Adding UV lamps should be selected with features that also eliminate ozone production
• Effectiveness of UVGI is influenced by the increase in humidity.
Types of UV-C Disinfection systems

- UV-C In-Duct Air Disinfection
- UV-C Upper-Air Disinfection
- UV-C In-Duct Surface Disinfection
- UV-C Portable Room Decontamination
General HVAC Recommendations
General Recommendations

• Maintain normal thermal comfort conditions of 68-78°F (20-25°C) and 40-60% relative humidity (RH).

• Increase ventilation rates as per the corresponding ASHRAE Standards

• Increase the filtration to a MERV 13 filter, and wear PPE during filter replacements

• Operate restroom exhausts continuously

• UVGI systems should be maximally operated according to manufacturer instructions

• Pressurization in the Lobby to reduce the stack effect should be maintained.

• Operate stand-alone air cleaners in the area where most people in the household spend their time.

These recommendations work for both commercial and residential building
Recommendations for Commercial Buildings

• Identify HVAC System characteristics, review As-Built and Design drawings. Compile and review O&M Manuals.

• Verify HVAC controls are operable, remote monitoring available and alarming capabilities. Include IAQ sensors (CO2, PM 2.5, NOx,..) if necessary.

• Continued operation of all systems is recommended during occupied hours.

• Study the stack effect within the building

• Turn on the ventilation fans for:
  1. Kitchens
  2. Toilets
  3. Elevators
  4. Stairs
Recommendations for Commercial Buildings

- Evaluate building occupied hours, adjust as necessary (have building hours been extended to encourage physical distancing).
  1. Flushing sequence or mode should be implemented to operate the HVAC system with maximum outside air flow for two hours before and after occupied times,
  2. If the building has people in after hours (cleaning crew,...) operate the IAQ measures based on the number and the spaces they occupy only
- Evaluate the supply and return air positions within the rooms, so air passageway avoids occupants, beware of horizontal flow.
- Consider diverting exhaust outlets that near pedestrian areas
- Consider opening windows only during occupied hours as an enhancement for outside air, if needed
Energy versus Indoor Air Quality

- Pollutant concentration, IAQ
- Energy demand

Pollutant concentration, $[\mu g/m^3]$

Decrease ventilation rates and save energy use

Acceptable IAQ

Increased ventilation and reduced pollutant concentrations
Energy vs. IAQ

• Some measures are easy to apply:
  1. Placing MERV 13 filters instead of MERV 8,
  2. Properly sealing the filter slot, to ensure no air bypass
  3. Calculating the ventilation rate based on corresponding ASHRAE Standards
  4. Setting up the IAQ measures during occupancy hours only, and an hour or two before and after the occupancy schedules
  5. Placing the adequate exhaust fans for toilets and kitchens at the proper air flow rate based on ASHRAE Standards
General Environmental Concerns

• The measures taken do not contribute to the increase of HFC and ODS emissions.
• Building owners are to study their buildings carefully to implement the most suitable IAQ measure with minimal energy increases.
• Epidemic protections do not necessarily need to impose permanent energy penalties. They can be used intermittently when needed.
• ASHRAE continuously advances the HVAC&R field by performing research and developing guides and standards for designing systems that:
  1. minimize energy consumption,
  2. reduce emissions of high global warming potential refrigerants,
  3. include resiliency to extreme weather events.
• ASHRAE promotes the responsible use of refrigerants processes of design, manufacturing, operation, and servicing of systems as well as at the end of life.
Thank You