Our Road to **Net Zero** Greenhouse Gas Emissions

Adopted in 2015, the Paris Agreement sets out a global framework to avoid dangerous climate change by limiting global warming. The agreement requires deeper emissions reduction commitments from all countries, whether developed and developing.

In the spirit of the Paris Agreement, Daikin has formulated **Environmental Vision 2050**, with a target of reducing greenhouse gas.

DAIKIN

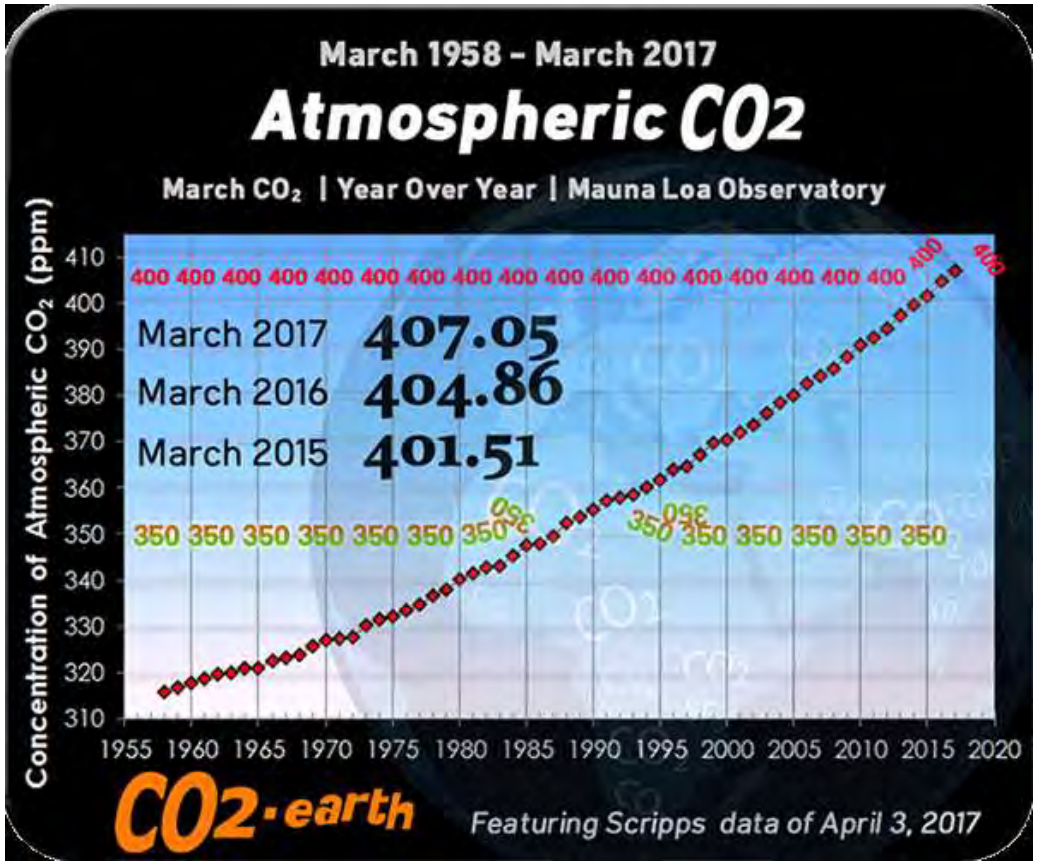
Environmental Vision 2050

- We will reduce the greenhouse gas emissions generated throughout the entire life cycle of our products.
- We will create solutions that link society and customers as we work with stakeholders to reduce greenhouse gas emissions to net zero.
- Using IoT, AI, and open solutions, we will meet the world's needs for air solutions by providing safe and healthy air environments while contributing to solving global environmental problems.

DAIKIN AIR INTELLIGENCE

Saving Energy is Important

- CO_2 Increase ➔ Climate Change
  - ~25% in my lifetime ~320 ➔ 407 ppm
  - 100% in grandkid's lifetime 400 ➔ 800+ ppm



Pope Francis' encyclical
Laudato Si'
ON THE CARE OF OUR COMMON HOME

IAQ is Important

Control of Infectious Aerosols: ashrae.org/covid19

Americans spend ~87% of their time Indoors
~70% at Home

Klepeis (2001)

Gaseous Contaminants of Concern (CoC):

Formaldehyde (HCHO):

"Known to be a human carcinogen"

US National Toxicology Program

12th & 13th Report on Carcinogens (2011, 2014)

Carbon Dioxide (CO_2): Maybe not just a surrogate

Decision making performance reduced 600 → 1000 ppm CO_2

Satish et al. (2013)

"…no indication that CO2 should be considered harmful…" Zhang et al. (2017)

Formaldehyde is Ubiquitous in Homes

- Proposed by Sherman & Hodgson (2004)
- Reference levels range from 7- 81 ppb
- If C_{HCHO} < ? What % of samples have no other VOC CoC
- Database of VOC & Aldehyde Air Samples in N. America




BUILDING ENERGY & ENVIRONMENTS

THE UNIVERSITY OF TEXAS AT AUSTIN

Balancing IAQ and Energy Use in Homes

Dissertation Defense

17 April 2017

Mark Cree Jackson, MSE, MBA
PhD Candidate
The University of Texas at Austin
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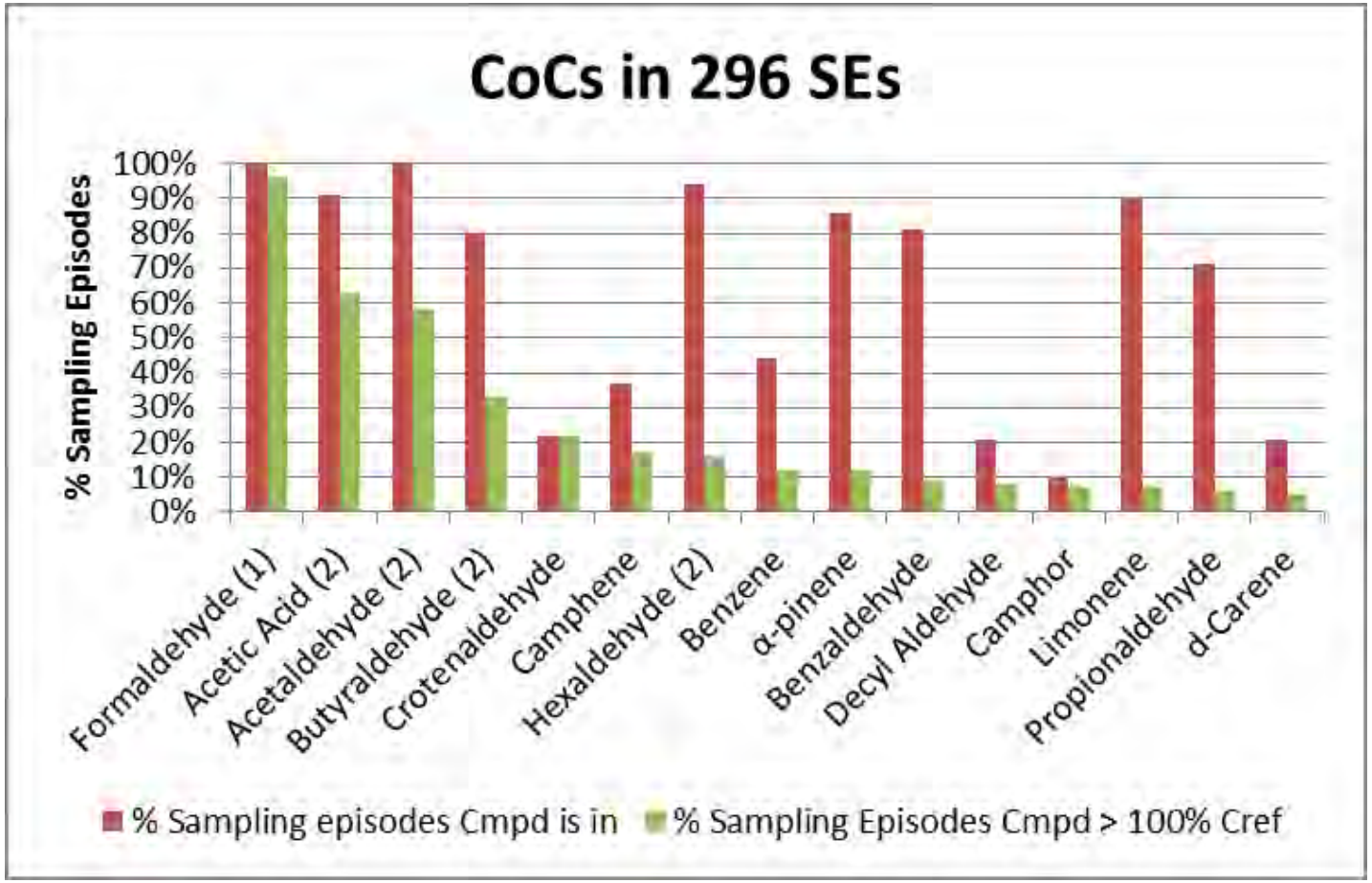
Aldehydes are key CoC



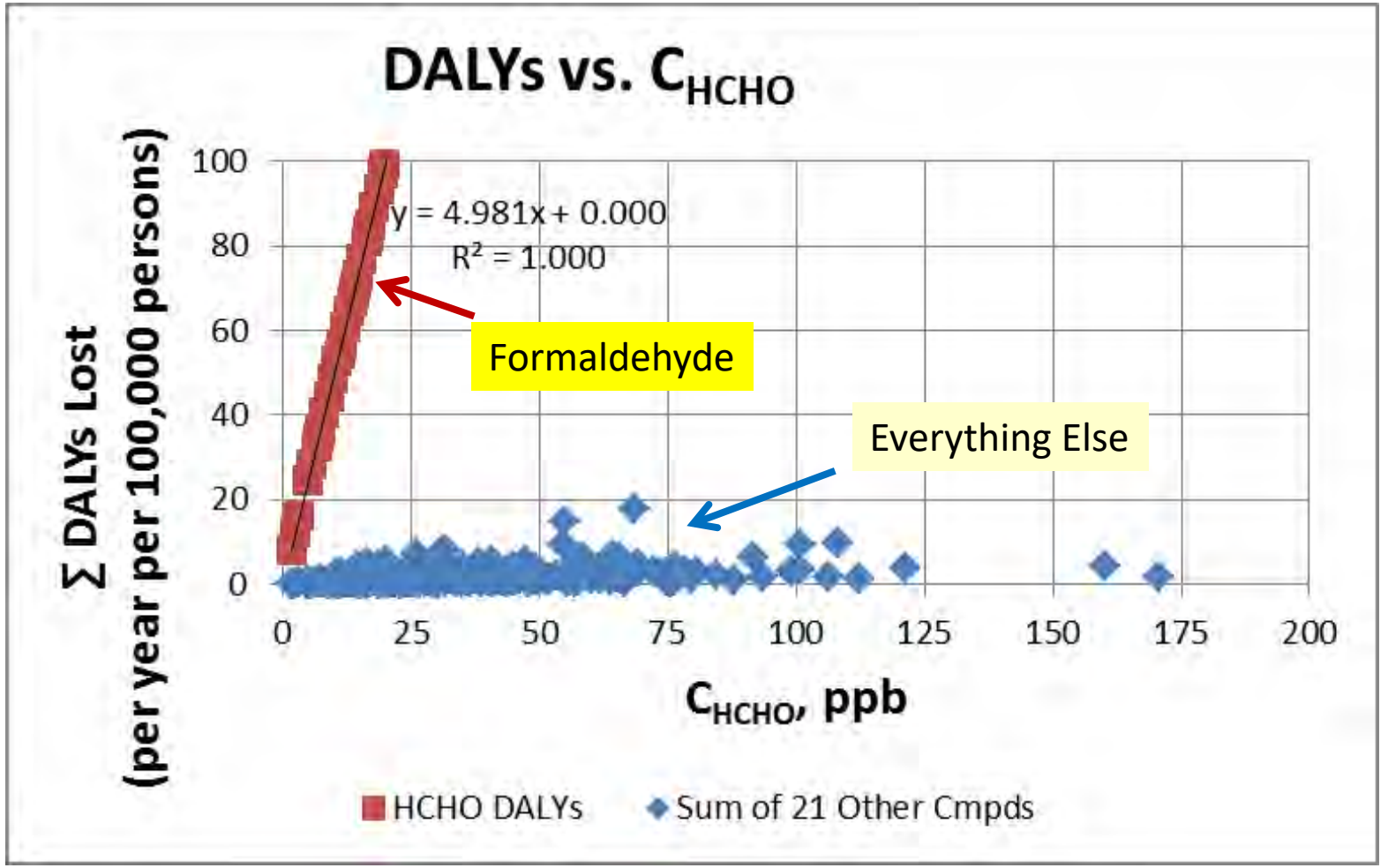
Criteria: Occur & > C_{ref} in ≥ 5% Sampling Events

(1) CA OEHHA cREL used for formaldehyde
(2) Short-term ESL used as it is lower than long-term ESL

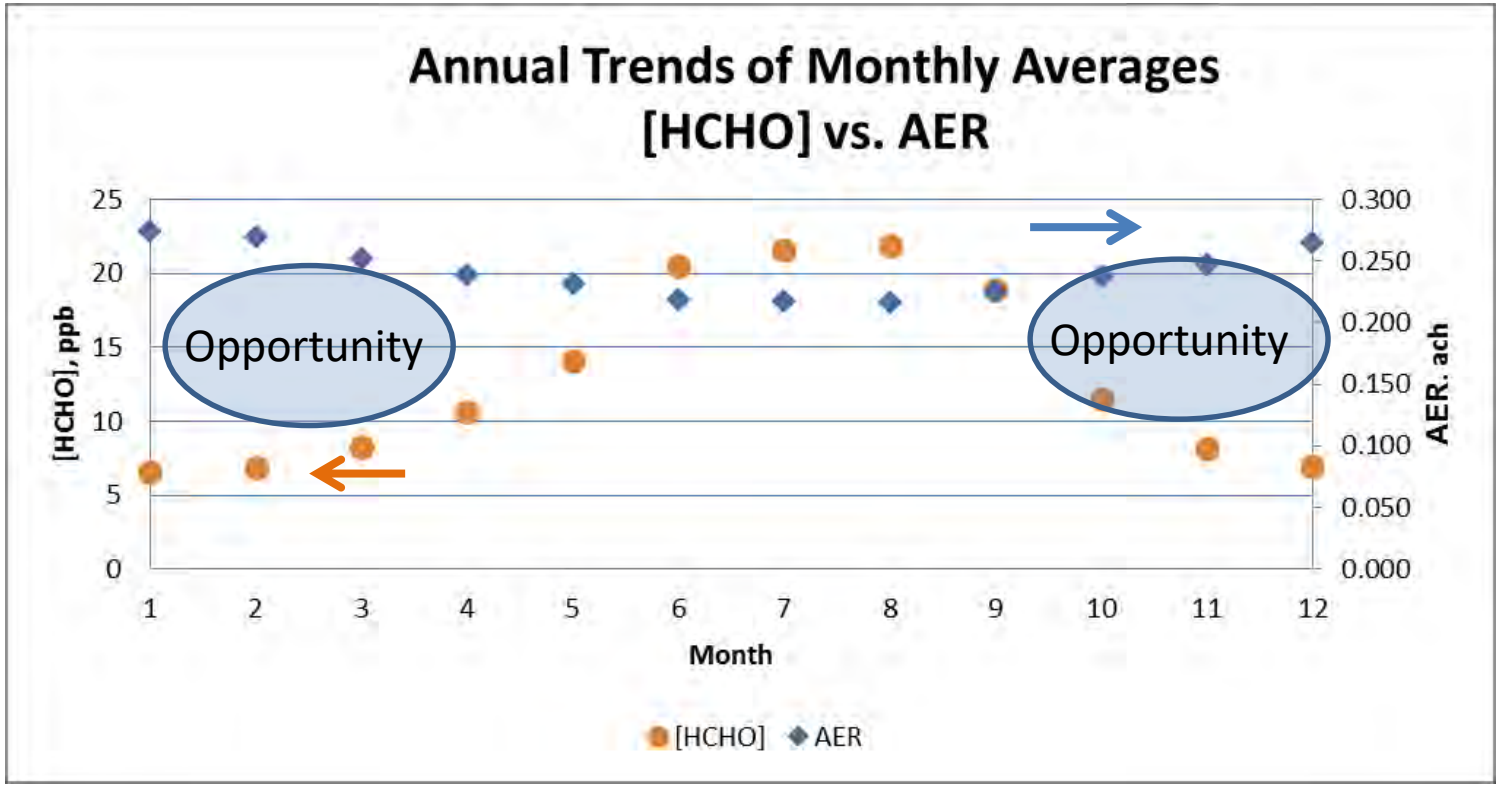
HCHO Dominant CoC in Database

20 ppb HCHO ➔ 100 DALYs/100,000 person years

➔ 1:1000 risk of 1 DALY loss per year



Ventilation requirements change with season

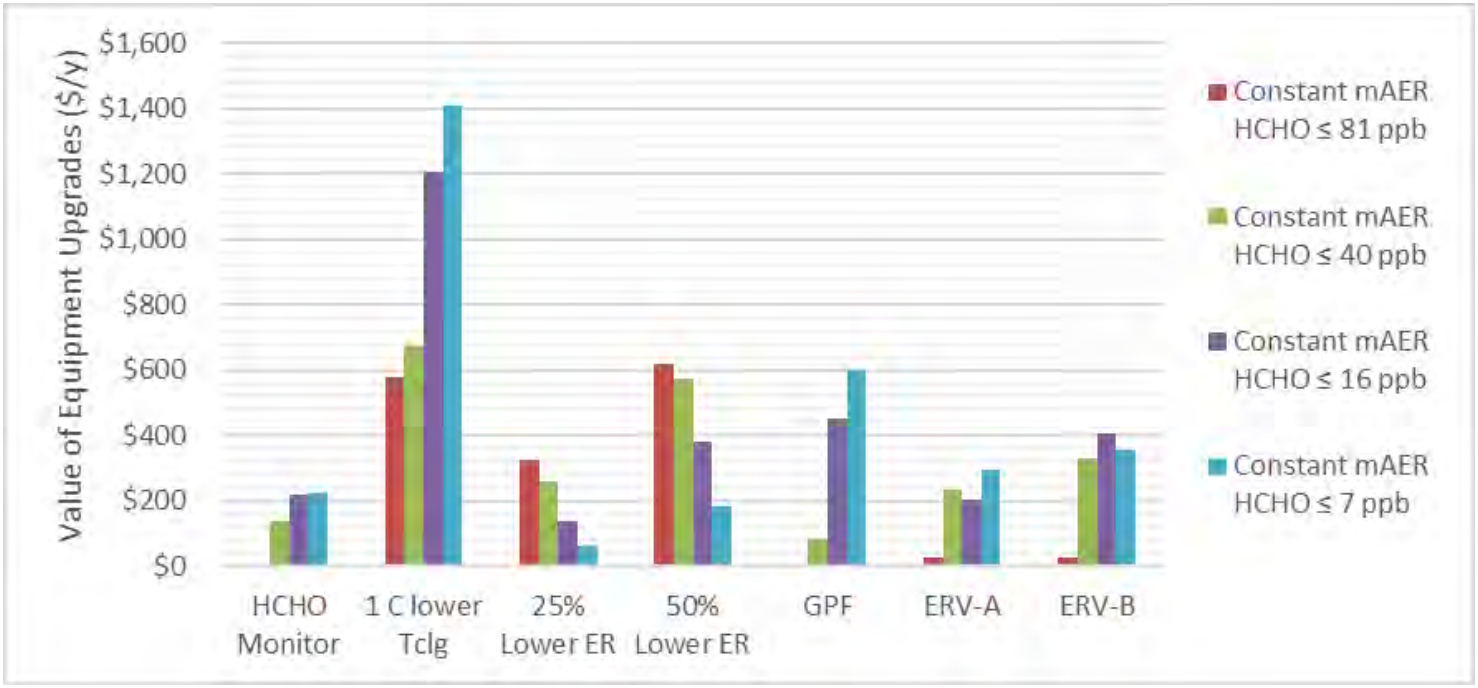


Conclusions

"HCHO good IAQ metric"

- HCHO is ubiquitous
- HCHO a significant CoC in and of itself
- HCHO correlates well with 14 of 15 CoC
- C_{HCHO} good indicator of additional CoC
- HCHO key component of Hazard Index
- HCHO Dominates known DALY impact of VOCs

Practical implications



Value of upgrade to achieve C_{HCHO} = 16 ppb:

↓ T_{Clg} > GPF > ERV-B > 50% Lower ER > HCHO Monitor > ERV-A > 25% Lower ER

$1,200/yr $150/yr

Daikin *Air Intelligence* - Visualizing IAQ

Daikin *One* Ecosystem

Aspects of the Daikin *One* Ecosystem

- **Detect:** Air quality sensor monitors levels of particulates and chemicals
- **Visualize:** Display sensor readings on Daikin Controller and smartphone App
- **Act:** Air cleaner and Daikin branded powered ventilator will reduce harmful contaminants

Link to Daikin *One* Ecosystem Video:
https://www.youtube.com/watch?v=ZyNHZFjivnI

DAIKIN AIR INTELLIGENCE

Daikin *One Ecosystem* – Enabling Solutions for Better IAQ

New comprehensive brochure educates consumers on the benefits of IAQ and unique Daikin solutions

Daikin Unique Solutions

A schematic of all the many IAQ solutions we have available.

Using Daikin One with the Home Air Monitor allows you to detect, visualize, and act when events occur.

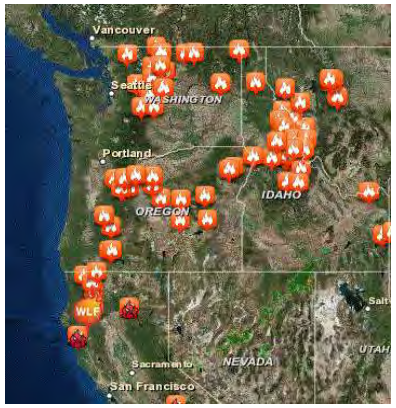
DAIKIN *One* Premium Air Cleaner

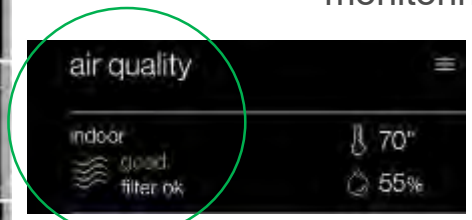
- Includes MERV 15 media filter, removes more than 87% of particles down to 0.3 micron
- Room Temperature Catalyst (RTC) insert degrades formaldehyde and ozone
- Long life, high capacity filters can last up to one year before needing changed, based on conditions within the home
- Magnetic door design ensures tool less ease of access to filter components.
- Extra deep, 13.3 cm (5 1/4 inch) pleated filter
- Insulated Cabinet
- Filter has a tight cabinet fit ensuring minimal air bypass
- Door gasket for proper air seal
- Heavy duty, 20 gauge, post-painted, corrosion resistant cabinet and door
- Cabinet mounting holes slotted to lineup with original equipment for time saving installation
- Designed for multi-position horizontal or vertical positions

January 2021

Daikin Premium Air Cleaner (without RTC) available now

Practical example of active monitoring and DPAC





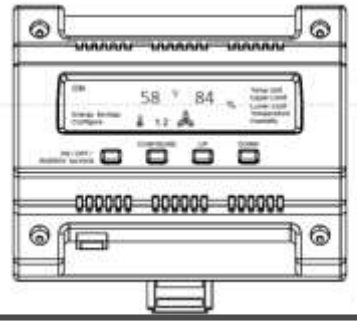
Indoor space is maintained clean and healthy with Daikin filtration and active monitoring/schedule.

Premium Features

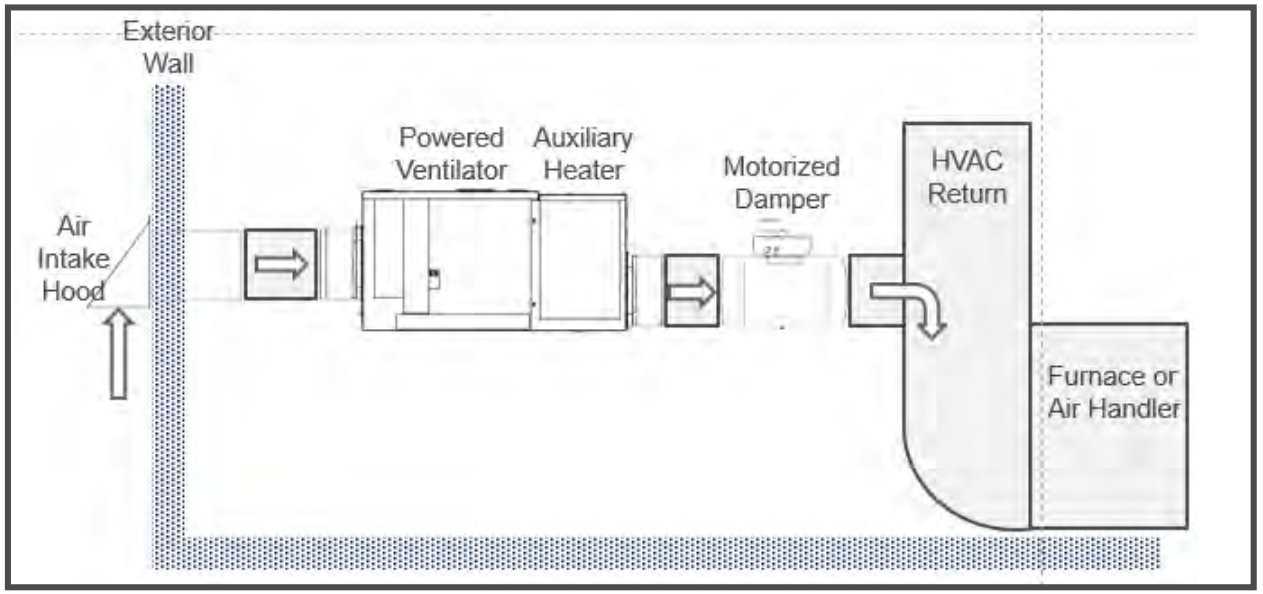
- Designed to improve IAQ with ventilation
- 68 – 170 m^3/hr (40 – 100 cfm) of outdoor air
- Filters incoming outdoor air (MERV 16 filter)
- Insulated cabinet
- Easy ASHRAE 62.2 Sizing Calculations
- Multiple mounting configurations (joist, rods, stand)
- Accessories (heater, motorized damper)
- Simple wiring with harnesses
- Intuitive programming with enthalpy control

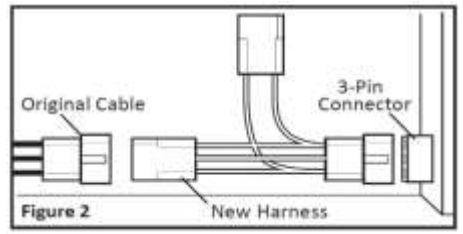
Ventilation rate (CFM) =
[0.03 x floor ft^2] + 7.5 x [# of rooms + 1]

Controller has energy savings mode and enthalpy control with scheduling



Typical horizontal install





Easy wiring

Daikin *One* Home Air Monitor

Detect: The Daikin Home Air Monitor tracks the levels of particulates and chemicals within the entire home or space.

- In-duct design allows for whole home monitoring
- Low maintenance with fan-less design
- Monitors and reports VOCs and PM
- Lab-grade sensors
- Individually calibrated
- Available only through Daikin Comfort Pros
- IAQ **EVENT** monitor (not absolute)

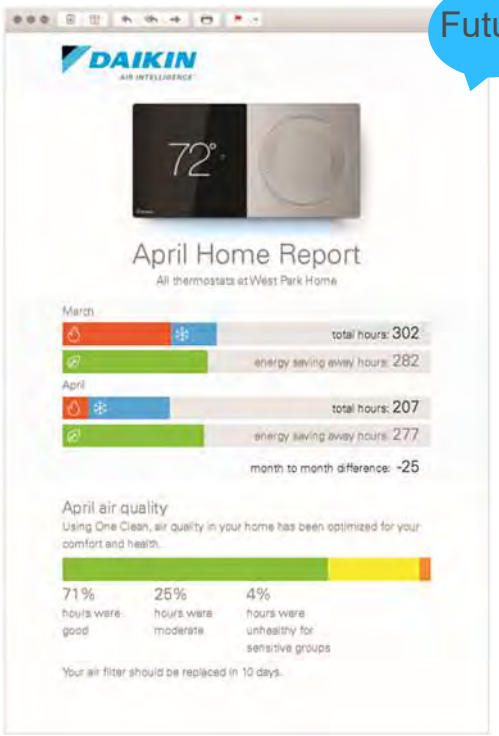
DAIKIN AIR INTELLIGENCE™

DAIKIN AIR INTELLIGENCE

DETECT & VISUALIZE - Daikin *One* Whole Home Air Monitor

Part No: DSEN-HAQA

Future



8.1 Air Quality

8.2 Indoor (good)

8.3 Indoor (moderate)

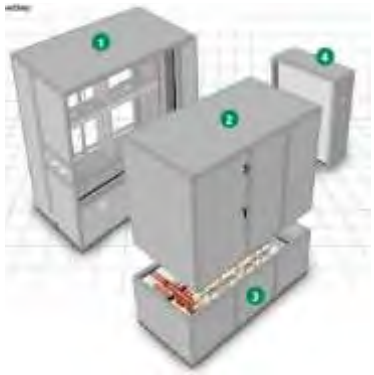
8.4 Indoor (action needed)

- Indoor vs. Outdoor ➔ show Green Good /Yellow Moderate /Orange Action Needed
- Particle Event– show Green/Yellow/Orange – and relative magnitude of event
- Chemical Event – show Green/Yellow/Orange – and relative magnitude of event

DAIKIN AIR INTELLIGENCE

A Tower for the People: 425 Park Avenue

- HBS Case Study (3/5/2020)
- Redevelopment project of an existing 1950s 30-story into a new multi-use 47-stories.
- Vertical Self-Contain Units allow ventilation to each floor
- Focus on Enhanced Ventilation (DOAS) and Filtration
  - *“Higher Ventilation could also significantly improve occupant performance, including productivity and cognitive function.”*
  - *“A building with an industry-standard MERV8 filter removes about 50% of particles, while a MERV13 filter has a capture efficiency closer to 90%.”*



FILTRATION MITIGATION STRATEGY

Particle Size Range	Minimum Efficiency %								
	MERV 8	MERV 9	MERV 10	MERV 11	MERV 12	MERV 13	MERV 14	MERV 15	MERV 16
0.3 - 1.0 µm	N/A	N/A	N/A	$E_1 \geq 20\%$	$E_1 \geq 35\%$	$E_1 \geq 50\%$	$E_1 \geq 75\%$	$E_1 \geq 85\%$	$E_1 \geq 95\%$
1.0 - 3.0 µm	$E_2 \geq 20\%$	$E_2 \geq 35\%$	$E_2 \geq 50\%$	$E_2 \geq 65\%$	$E_2 \geq 80\%$	$E_2 \geq 85\%$	$E_2 \geq 90\%$	$E_2 \geq 90\%$	$E_2 \geq 95\%$
3.0 - 10.0 µm	$E_3 \geq 70\%$	$E_3 \geq 75\%$	$E_3 \geq 80\%$	$E_3 \geq 85\%$	$E_3 \geq 90\%$	$E_3 \geq 90\%$	$E_3 \geq 95\%$	$E_3 \geq 95\%$	$E_3 \geq 95\%$

- **AAF/Flanders is a part of Daikin International**

- "The use of highly efficient particle filtration in centralized HVAC systems reduces the airborne load of infectious particles"*

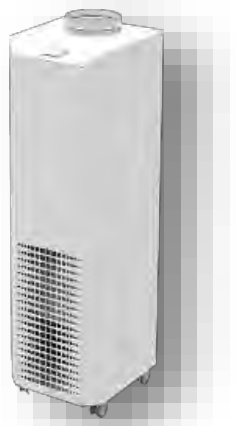
- **ASHRAE 52.2 MERV 13 are efficient at capturing aerosolized respiratory droplets sized 0.5 µm to 5.0 µm. Therefore, the minimum recommended final filter rating is MERV 13, MERV 14 preferred, or as best achievable without diminishing air flow***
- Market currently showing 300% MERV 13 increase in demand YOY.
  - *Minimum recommended final filter rating is MERV 13,* consider using higher efficiency MERV 14, 15, 16 filters.
  - *'Or as best achievable'* can include lower efficiency MERV 12, 11, 10, 9 filters. Any increase in MERV rating over existing may reduce risk.

- **Increasing filtration will impact supply fan energy, systems need to be evaluated on a case-by-case basis if they are capable of handling increased filtration**

* ASHRAE Guidance for Filtration Disinfection during the COVID-19 Pandemic, March 27, 2020

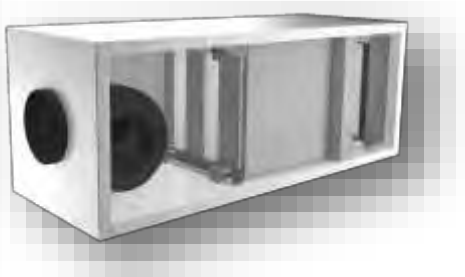
In Room Air Purifier

- Outline
  - Air purifier to respond to the pandemic challenges and the new demand for air cleaner in the occupied space, especially in office buildings, clinics and schools.
- Applications
  - Healthcare – exhaust or recirculation unit[1]
  - Office buildings – recirculation unit[2]
  - Small clinic/dentist – exhaust or recirculation[3]
  - Schools – recirculation[4]

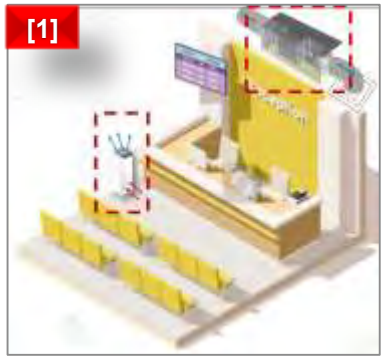


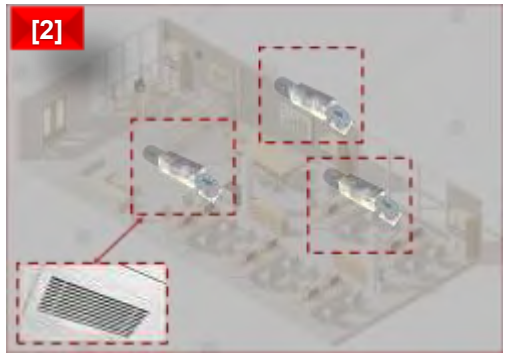
Exhaust Unit

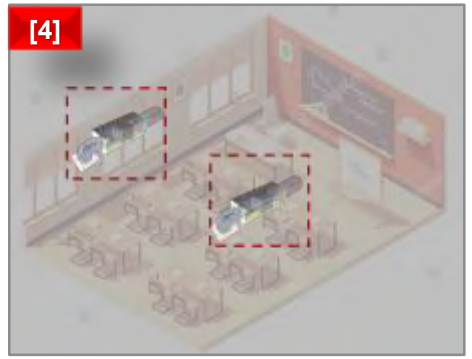
Recirculation Unit



Recirculation Unit







UV Lights – What you need to know

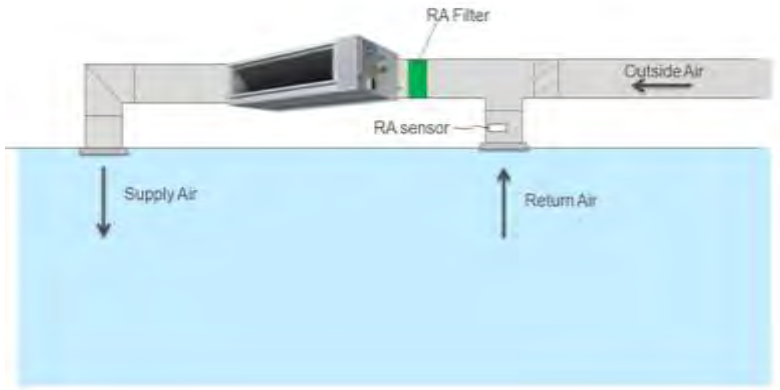
- According to ASHRAE Position Document on Infectious Aerosols:
  - Entire ultraviolet (UV) spectrum can kill or inactivate microorganisms
  - UV-C energy (wavelengths 200-280 nm) provides the most germicidal effect; 265 nm near optimal wavelength

- When evaluating UV lights, be sure to determine effective wavelengths and airflows based on manufactures guidelines
  - Can be difficult to retrofit
  - Evaluate airflow and wattage
  - Deteriorates interior

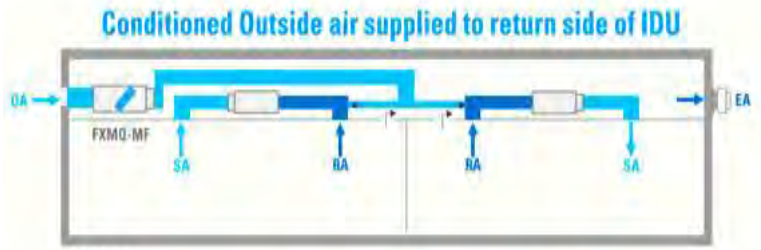
- Source: [ASHRAE Position Document on Infectious Aerosols]

VENTILATION STRATEGIES WITH VRV – DIRECT AND INTEGRATED

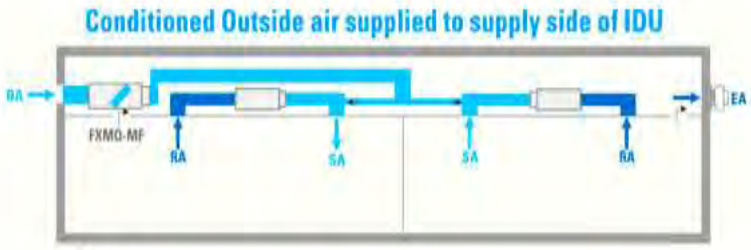
- **Direct Method**
  - OA is mixed with RA and conditioned by the VRF indoor unit.
  - OA ducted into the return air duct of the VRF indoor unit. If a ductless indoor unit is used, be aware that the manufacturer often restricts the OA amount to between 3-10% of the unit airflow rate, due to the size of the fresh air connection and the concern of noise.
  - Typically, low-cost design option; no additional equipment and separate ventilation air duct systems to pretreat and distribute the outdoor air.
  - Cons: untreated OA delivered to the space with no heating or cooling until the space thermostat calls for it. Too much humid outdoor air is pulled into the space it can cause occupants to feel uncomfortable.
  - Best used for application in mild to moderate climates, and or/situations requiring small amounts of outdoor air.



- **Integrated Method**
  - Reduces cost/space needed to install additional ductwork and separate diffusers.
  - Ventilation equipment lowers OA temperature entering the VRF indoor unit increasing ratio of fresh air allowable
  - Allows for flexibility of the VRF system to satisfy the ventilation requirement of large spaces with high occupancy.
  - Compared to the Direct Method, smaller capacity indoor unit selection and better comfort/performance especially at part load operation.



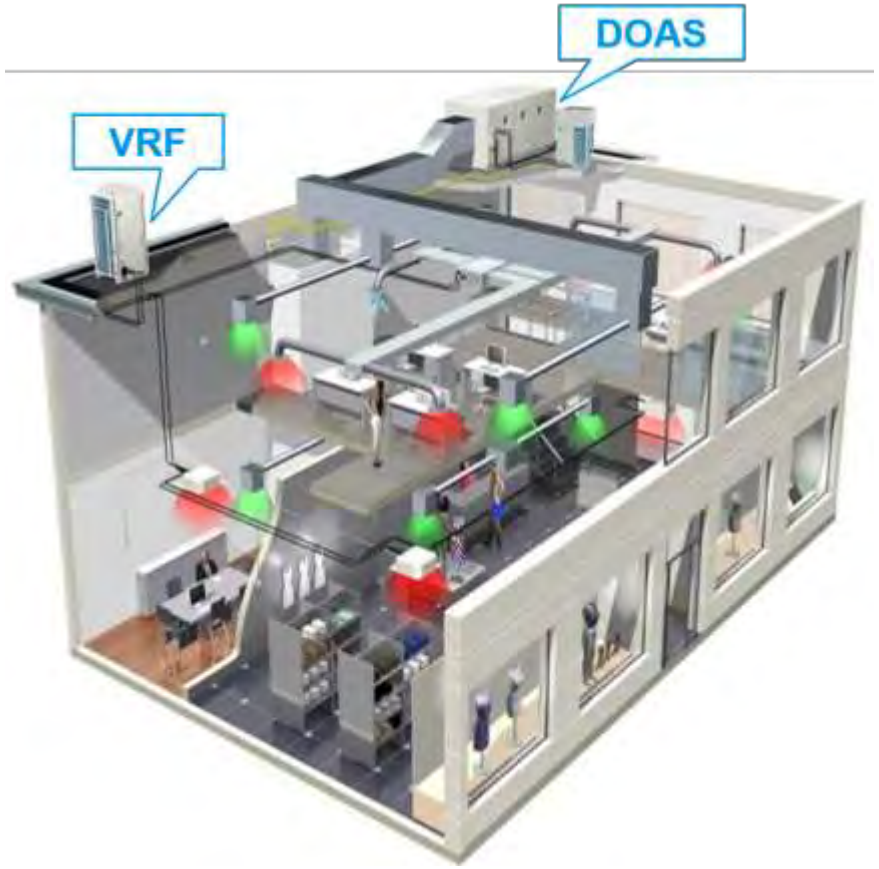
Notes
- If the conditioned outdoor air is delivered at a cold temperature rather than a neutral temperature, it results in cool air entering the coil in the IDU. This must be considered during equipment selection, as it may impact IDU capacity



Notes
- If the outdoor air is delivered at a cold temperature, rather than reheated to near space temperature, this configuration can offer the opportunity to downsize the IDU. However, measurement and balancing are usually more difficult in this scenario than when the outdoor air is delivered directly to the space.

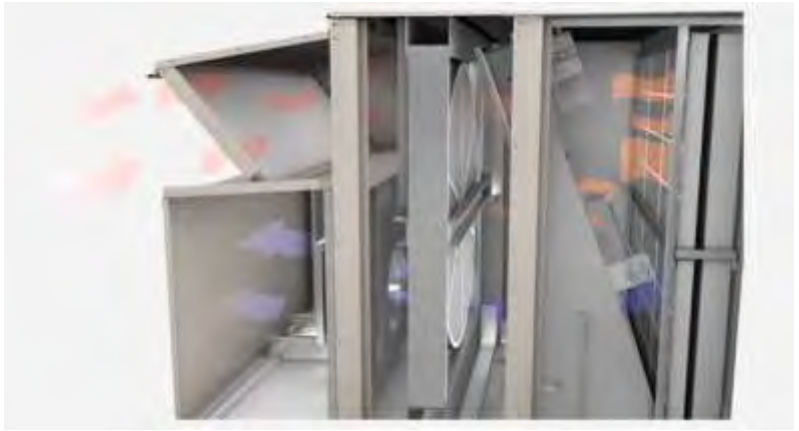
VENTILATION STRATEGIES WITH VRF – DECOUPLED

- Ventilation duct is dedicated to deliver fresh air to all occupied zones and is separate from the heating/cooling duct.
- Introduce any amount of OA needed and larger amounts of OA where required.
- ASHRAE Standard 62.1 requires occupied spaces be held below 65% relative humidity becomes achievable at part-load cooling conditions with VRF and DOAS
- The VRF indoor unit fan can be programmed to cycle on/off based on heating and cooling requirements, regardless of ventilation demands, thus increasing system efficiency.



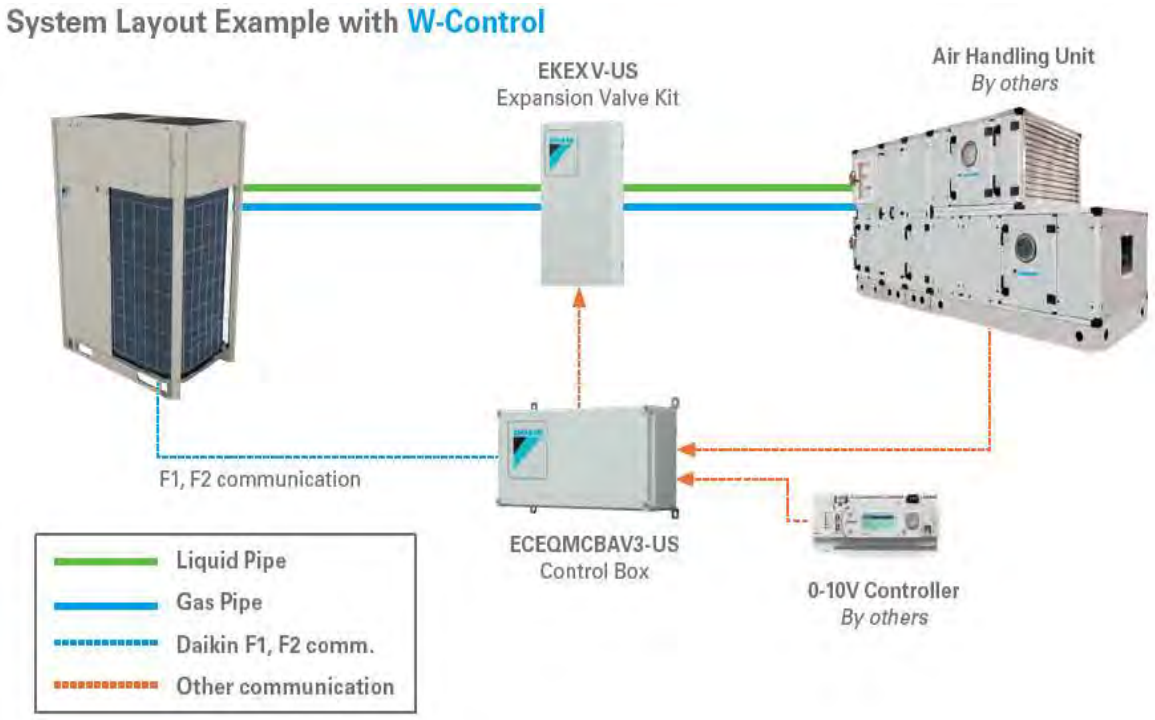
VENTILATION OFFERINGS – REBEL AND REBEL APPLIED

- DOAS option available across all tonnages, including ERV options
- ECM fan array provides airflow redundancy
- Filtration option to true HEPA
- Inverter compressor
- Advanced control capabilities
  - Remote monitoring
  - Humidity sensor



VENTILATION WITH VRF - ADDITIONAL STRATEGIES

› Using Expansion Valve kit allows for the integration of semi-custom or fully custom AHUs - driven by VRV



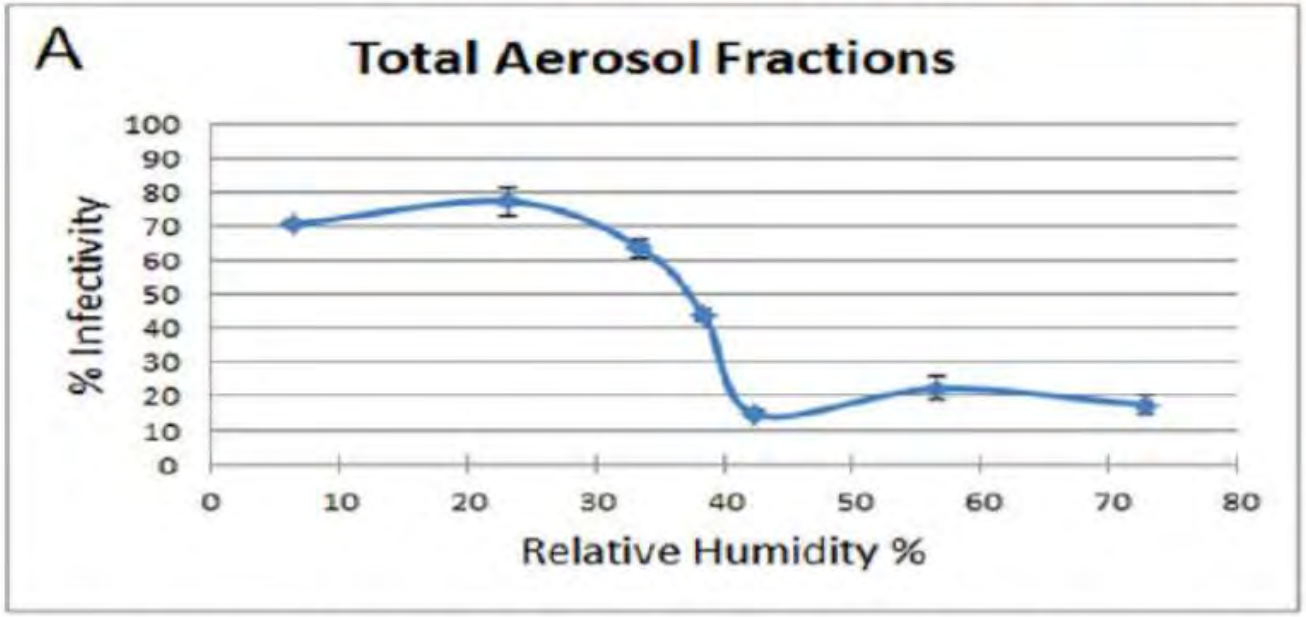
VENTILATION OFFERINGS - DOAS WSHP

- DOAS system to separate ventilation air delivery from space conditioning units can be more accurately controlled
- Separating the load of the ventilation air, the size and operation of the space conditioning units can be reduced and optimized to improve occupant comfort and overall system efficiency
- Constant or Variable Air Volume
- 4” MERV 13 Filter option
- SmartBoost Heating Technology
  - Allows OA to enter unit as low as 0°F, without pre-heat

MAINTAIN TEMPERATURE AND HUMIDITY

What do we know* about Airborne Transmission?

Relative Humidity between (40%-60%) slows the Transmission of Viruses



Influenza A is the subject of the study

*High RH results in droplet stability

** Noti, John D., et al. "High humidity leads to loss of infectious influenza virus from simulated coughs." PloS one 8.2 (2013).*
** Wan Yang and Lindsey Mars, "Mechanisms by Which Ambient Humidity May Affect Viruses in Aerosols", 2012 Oct.*

› ASHRAE: Re-opening our schools: Activities & Recommendations Webinar (6/16/2020)