Application Solution

Indoor Air Quality and COVID-19

SUMMARY

- Monitoring CO2 is the most efficient way to ventilate. CO2 measures exhaled breath and, implicitly, when there is a risk of transmission.
- VOC's can be an indicator for dangerous air. Monitoring VOC's for ventilation will mean refreshing it more often, but may mean more energy costs.
- PM2.5 sensing is a good indication of cleaner air and proper filtration.
- CO2 and VOC sensors are both useful indicators for how often to refresh air in a building while PM2.5 can indicate if and when additional filtration is needed. Each sensor technology discussed has benefits and drawbacks so a combination of technologies is the ideal solution.

INDOOR AIR QUALITY AMIDST A PANDEMIC

Indoor air quality has always been important for keeping building occupants comfortable, but it is more important than ever amidst the global COVID-19 pandemic. COVID-19, along with many other respiratory illnesses, is spread through large and small droplets and particles that may be suspended in air. Thus, many families are greatly concerned with air quality in their work, school, and living spaces. The HVAC industry is now tasked with finding smarter ways to monitor air quality and ventilate spaces more thoroughly.

This article aims to explore the sensor technologies we have at our disposal and how each can be used to make buildings safer and occupants more comfortable.

CO2 SENSORS

HVAC systems have traditionally been designed to ventilate spaces according to CO_2 levels. CO_2 is not a contaminant at normal levels; it has no toxic effects until about 50,000 ppm concentration[e]. The level of CO_2 simply indicates whether a room is occupied so more air can be supplied to refresh the air quality.

This method is the most efficient means of monitoring air quality, as it will trigger ventilation if and only if a room is occupied enough to see CO_2 levels rise. ASHRAE standard 62.1 Ventilation for Acceptable Indoor Air Quality [b] suggests maintaining a steady-state CO_2 concentration of 1100 ppm or less so a "substantial majority of visitors entering a space will be satisfied with respect to human bio-effluents (body odor)."

Senva offers a variety of options for CO2 sensing. From left to right is (1) the full featured AQW series combination CO2, Humidity, and Temp sensor, (2) the CO2RL recessed wall CO2 and Temp sensor, and (3) the CT1D series duct-mount CO2 and temp sensor. Learn more here: https://www.senvainc.com/en/products/indoor-air-quality

See Senva's Air Quality Products

With respect to COVID-19, exhaled breath is the most common path of transmission and is also the main source of CO_2. Consequently, monitoring for CO_2 can let building owners and controllers know how much exhaled breath is in the air and, implicitly, when there is a risk of transmission of disease. However, at the expense of some energy savings, it may be prudent to choose a lower steady-state CO_2 concentration to provide a higher level of safety and reassurance to occupants.

VOC SENSORS

A less popular but growing technology in the industry is VOC sensors. VOC stands for volatile organic compounds and VOC's come from thousands of sources. Contaminants include paints, glues, inks, cleaning agents, smoke, rotten food, building products, and a myriad

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of other harmful or offensive gases. VOC's emitted by common office equipment like printers and paint have been linked with common cold and flu-like symptoms [a]. This phenomenon is known as "sick building syndrome" and monitoring for VOC's may be a practical method of avoiding it. Finally, VOC contaminants are found in exhaled breath, making these sensors a logical substitute or compliment to CO_2 occupancy sensing.

There are thousands of contaminants that will elevate VOC levels and, while it is likely that ventilation is necessary when many are present, it may also mean an increase in total ventilation. As conditioning air is expensive and indoor air quality has not been a major concern of occupants until recently, this has made this technology less popular than CO_2 sensing. Using a VOC sensor for ventilation control will typically mean a building's air is refreshed more often, but it may, unfortunately, mean ventilating a room because the trash hasn't been taken out.

At present, VOC sensors are making a comeback due to the growing concern over air quality. VOC levels have been found to be more pronounced in occupants who have tested positive for COVID-19 [f]. Some scientists are even evaluating nano-material based VOC sensors for the potential of COVID breathalyzer tests [d].

Does this mean a typical VOC sensor can tell us whether there is COVID in a room? It is highly unlikely. But it does suggest that VOC's are a good benchmark for measuring the health of the air an occupied space.

PARTICULATE MATTER (PM)

Particulate matter sensors can measure the presence of

certain sizes of particulate. A PM2.5 sensor will indicate the presence of particles that are about 2.5 um or smaller and a PM10 sensor will measure only larger particles. Particulates range in size and source but most come from industrial processes, power plants, fossil fuel emissions, unpaved roads, wildfires, mold, pollen, and other allergens. Particulate matter is used by the Environmental Protection Agency as a measure of pollution.

There is a correlation between areas with higher PM concentrations and the spread of COVID-19 [c]. This could mean two things: it could mean that PM in the air creates a pathway for virus transmission or it could be related to the fact that prolonged exposure to particulate matter can inflame the lungs and lead to a weakened immune system. There is evidence to support both theories. In either case, monitoring IAQ for particulate matter could help us to understand more and keep buildings safer.

The use of PM2.5 sensors will not indicate occupancy in a room, nor will it indicate the presence of odors. However, it is an indication of healthy air and whether air is being properly filtered within a space. If PM2.5 can be measured and systematically reduced in a building, it may lead to healthier occupants.

[a] Apte, M. G., and J. M. Daisey. 1999, Https://Eta.lbl.gov/Sites/All/Files/Publications/42698.Pdf, Lawrence Berkeley National Laboratory.

[b] "ASHRAE Standard Ventilation for Acceptable Indoor Air Quality." Standards 62.1 & 62.2, ASHRAE, Inc., 2007, www.ashrae.org/technical-resources/bookstore/standards-62-1-62-2.

[c] Comunian, Silvia, et al. "Air Pollution and Covid-19: The Role of Particulate Matter in the Spread and Increase of Covid-19's Morbidity and Mortality." International Journal of Environmental Research and Public Health, MDPI, 22 June 2020, www.ncbi.nlm.nih.gov/pmc/articles/PMC7345938/.

[d] Haoxuan, Chen, et al. "Breath-Borne VOC Biomarkers for COVID-19 ." MedRxiv, State Key Joint Laboratory of Environmental Simulation and Pollution Control, College of Environmental Sciences and Engineering, Peking University, Beijing, China, 24 June 2020, www.medrxiv.org/content/10.1101/2020.06.21.20136523v1.full.pdf.

[e] Permentier, Kris, et al. "Carbon Dioxide Poisoning: a Literature Review of an Often Forgotten Cause of Intoxication in the Emergency Department." International Journal of Emergency Medicine, Springer Berlin Heidelberg, Dec. 2017, www.ncbi.nlm.nih.gov/pmc/articles/PMC5380556/.

[f] Shan B;Broza YY;Li W;Wang Y;Wu S;Liu Z;Wang J;Gui S;Wang L;Zhang Z;Liu W;Zhou S;Jin W;Zhang Q;Hu D;Lin L;Zhang Q;Li W;Wang J;Liu H;Pan Y;Haick H; "Multiplexed Nanomaterial-Based Sensor Array for Detection of COVID-19 in Exhaled Breath." ACS Nano, U.S. National Library of Medicine, pubmed.ncbi.nlm.nih.gov/32808759/.

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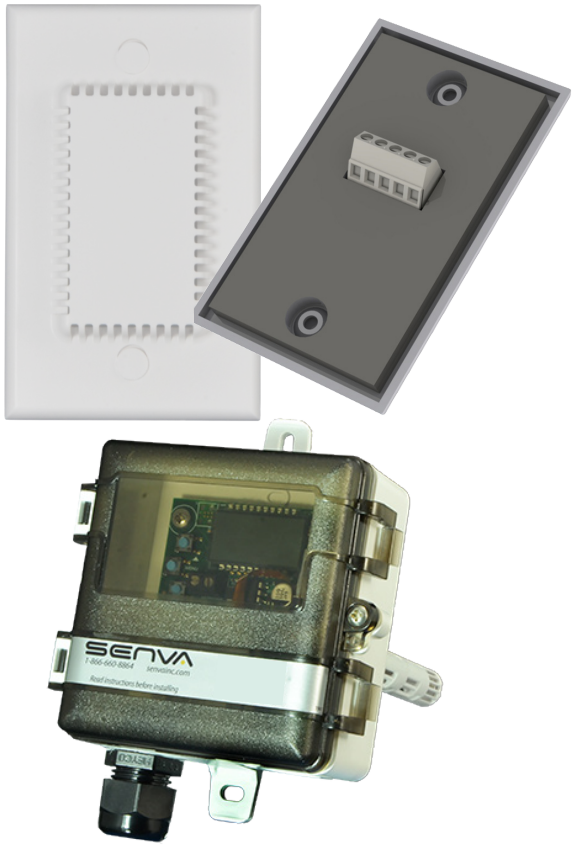
SENVA'S VOC SOLUTION

Available in wall-mount or duct versions, Senva's VT0R is capable of sensing thousands of VOC's coming from sources such as those listed in this application note. It's ability to sense these contaminants in addition to breath and other bodily funcitons makes it the preferred alternative or compliment to CO2 occupancy sensing.

The VT0R Value Series ensures that odor and ventilation issues are never a topic of conversation. An array of analog outputs and thermistor options accommodate any installation and keep occupants breathing easy. Visit Senvainc.com or call your Senva sales rep today at 1-866-660-8864.

See Senva's Air Quality Products



Sleek and functional design

- Standard wall plate size fits most single gang junction boxes
- Flush-mount screw plugs for tamper-resistance
- Duct model is great for ionization applications!
- Ideal for offices, schools, and hotels

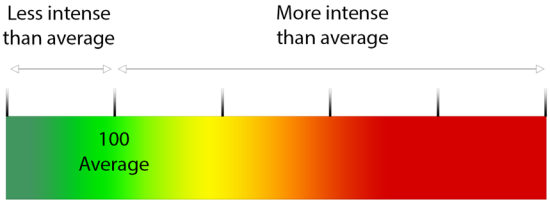
Superior sensing

- Humidity compensation for higher accuracy
- Gasket ensures excellent measurement accuracy

Industry-leading warranty

- 7-year limited warranty on electronics; sensor element 2 years

The output of this product has been converted from a raw VOC concentration into an intensity value, ranging from 0-500. An environment with normal air quality will typically read about 100 on this scale. Suggested control actions are listed to the right.



VOC Contaminant	Sources
Harmful Gases	Paints, glues, solvents, furniture, mattresses, carpet, flooring, building products
Other gases	Alcohol, cleaners, perfume, cooking smells
Odors	Rotten food, flatulence, breath, cosmetics, pet pee
Smoke	Cigarette smoke

VOC Level	Suggested Action
0-200	None, air quality is good
200-300	Ventilate, purify
300-500	Ventilate, purify intensely