Application Solution

# Demand Controlled Ventilation and PIR

## SUMMARY


- PIR motion detection enable instantaneous ventilation upon occupancy, ensuring higher air quality compared with lagging measurements.
- $CO_2$ is a practical means of determining how much air is needed, but may take up to 15 minutes to initiate ventilation
- Monitoring TVOC can help indicate unhealthy air and contribute to more favorable indoor air quality.
- PM sensing can validate new filtration methods including bipolar ionization as well as providing indication of total air quality.


## INDOOR AIR QUALITY AMIDST A PANDEMIC

Indoor air quality (IAQ) has always been important for keeping building occupants comfortable, but it is more important than ever amidst the global COVID-19 pandemic.

The Heating, Ventilation, and Air-Conditioning (HVAC) industry is now tasked with finding smarter ways to monitor air quality and ventilate spaces more effectively.

## PIR SENSORS VERSUS CO2

HVAC systems have been designed to ventilate spaces according to CO2 levels, using demand controlled ventilation (DCV). The level of CO2 typically indicates the level of exhaled air; as occupancy increases, CO2 rises. The ASHRAE standard 62.1 Ventilation for Acceptable Indoor Air Quality [a] suggests maintaining a CO2 concentration below 1100 ppm; typical systems will begin ventilation at 800 ppm.

Passive Infrared (PIR) sensors detect motion and have been traditionally used for lighting controls. A PIR sensor's ability to instantly and directly detect occupancy can also be applied to DCV strategies to provide fresh air faster.

TotalSense™ Series

*See Senva's Air Quality Products*

### CO2 Detection


### PIR Detection

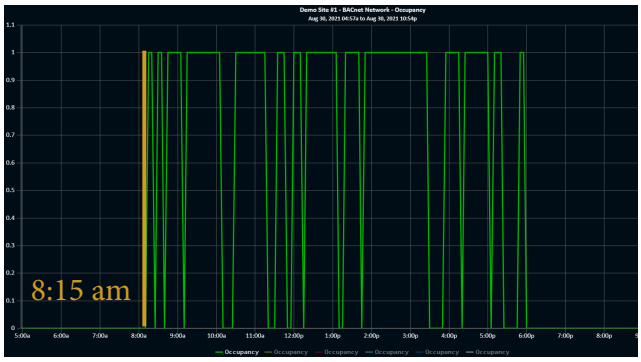


**Figure 1:** TotalSense readings for CO2 and PIR in a typical day in Senva's office.

To compare technologies, Senva installed several TotalSense IAQ sensors throughout the office. The above graph shows readings from the Sengineering wing which is occupied by 5-10 people on average. As you can see, the engineering office begins filling with occupants around 8:15 am, but the $CO_2$ level doesn't reach the 800 ppm standard ventilation threshold until lunchtime.

**Figure 1** shows that there is a 3.5 hour lag between the two 'occupancy' measurements. The Center for Disease Control and Prevention (CDC) considers 15 minutes within 6 feet of someone as 'close contact'; ventilation before this time limit could mean the difference between viral transmission and safety.

Using PIR occupancy, together with $CO_2$ measurements, could drastically reduce the amount of time a space is occupied but not ventilated.

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## A MATHEMATICAL APPROACH

A human exhales about 2.3 pounds of $CO_2$ per day[b]. We can use that assumption to calculate that a person in a 12x16x8' room (~44m$^3$) will contribute about 8.6 ppm per minute if the room is completely sealed. The below are estimates of the time to reach the standard 800 ppm ventilation trigger in a 12x16x8' room based on the number of adults with a baseline $CO_2$ of 400 ppm.

| Occupants | Est. Time to Reach 800 PPM |
|---|---|
| 1 | 40-50 min |
| 2 | 20-25 min |
| 3 | 15-20 min |
| 4 | 10-15 min |

Even with 4 adults, it takes up to 15 minutes to reach a $CO_2$ concentration high enough for a building automation system to deliver fresh air. This is plenty of time, according to the CDC, for a virus to spread.

## PIR RECOMMENDATION

Recently, many building owners have resorted to ventilating 100% of the time to overcome the issues related to $CO_2$ sensing for DCV. While this will mitigate the issue presented above, it is extremely inefficient and expensive. Adding a PIR sensor to the equation is a more effective strategy.

Using solely PIR for ventilation will likely mean a higher cost of conditioning air, but using only $CO_2$ may not provide enough air to be considered safe. Thus, Senva recommends a hybrid approach using PIR with up to a 5 minute time delay to initiate minimum ventilation and also using $CO_2$ to calculate air flow requirements.

## OTHER IMPORTANT IAQ MEASURES

### TVOC

TVOC stands for total volatile organic compounds which come from thousands of sources. Contaminants include paints, glues, inks, cleaning agents, exhaled breath, smoke, rotten food, building products, and a myriad of other harmful or offensive gases. VOC contaminants are also found in exhaled breath, making these sensors a logical substitute or compliment to $CO_2$ occupancy sensing.

Measuring and providing fresh air for high levels of TVOC in spaces can ensure the total air quality is favorable and safe for occupants.

### Particulate Matter

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.

In addition to ventilating more for safety, many industry professionals and politicians have shifted their focus and budgets towards implementing better filtration and purification methods. Techniques such as HEPA filters, ionizers, and other methods have been deployed in schools and workplaces, but the importance of measuring the effectiveness of these methods is often overlooked. PM sensors are able to provide information to building owners about the effectiveness of these filtration methods.

Particulate matter sensors can be used to indicate an important metric of healthy air as well as to evaluate the effectiveness of filtration strategies.

[a] "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.

[b] Palmer, Brian. "Waiting to Exhale." NRDC, 15 Dec. 2016, www.nrdc.org/onearth/waiting-exhale#:~:text=The%20average%20human%20exhales%20about,CO2%20as%20his%20sedentary%20brethren.). Medicine, Springer Berlin Heidelberg, Dec. 2017, www.ncbi.nlm.nih.gov/pmc/articles/PMC5380556/.