White Paper 10: Why CO2 is Terrible for Building Occupants

You Can't Manage What You Can't See

CO2—It's Great for Plants but Terrible for Humans

During the voyage of Apollo 13 in 1970, an oxygen tank onboard the service module ruptured. The blast also caused failures in the electrical and life support systems—not a good outcome when you're heading around the moon. As a result of the damage, Commander Jim Lovell moved the three astronauts to the lunar module. The LM was only designed for two crew members; it lacked enough CO2 scrubber capacity to keep the air adequately balanced. The movie is absolutely riveting. Not only did the team have to manually guide the spaceship back to earth, they created a new CO2 scrubber from a pile of parts collected from multiple and limited sources on board[1]. It was a real-life MacGyver moment. In the movie, the CO2 level peaked around 1400 ppm (parts per million).

A number of years ago our team was asked to provide CO2 and air quality monitoring for a client. After researching CO2 sensors and designing our first auto-calibrating unit, we installed it for testing at the client site. After collecting data for several days, we saw a pattern emerge where the CO2 level would drop to 800 ppm overnight and rise to 1400 ppm by 3 pm. None of us knew what it meant so we did a little research.

[1] According to the website space stack exchange: https://space.stackexchange.com/questions/41990/was-the-apollo-13-co2-problem-a-matter-of-capacity-or-of-rate : "4.5 mm Hg partial pressure of CO2 is equivalent to 5900 ppm (part per million) of CO2 in air at sea level. 14.9 is 19,600 ppm. The mean CO2 content of fresh outdoor air is about 400 ppm, low quality room air may have more than 1400 ppm."

The background level of CO2 in the atmosphere is between 350-400 ppm. It's lower in an Indiana corn field than Penn Station in New York City. After a little more digging we found a research report conducted at Harvard in 2017[2]. The report showed that human performance degrades linearly with a rise in CO2. Assuming baseline air is 400 ppm, a rise to 800 ppm causes human performance to drop 50%!

A month later we added real-time CO2 sensing to our portable demo kit. When visiting customers, we would power up the kit and collect sensor data at the start of the meeting. At the presentation conclusion we would share the CO2 level to check on the condition of the room. To our surprise, at least 20% of the meetings were conducted in rooms with CO2 level higher than 800 ppm! In one lunch-and-learn the level hit 1400! The customer immediately opened outside windows for ventilation. Every building owner and occupier needs a real-time view of CO2. You can't manage what you can't see. Most spaces are fine—but you won't know until you look. In the case of high CO2 levels, customers need to take immediate action to keep their employees healthy and productive.

With the high cost of employees, it's cheaper to change the air than add people. The energy stored in the air (heat or cold) costs 1% of the employee expense. In real estate terms this is the 3, 30, 300 rule. The rent costs 10x the energy bill; the People inside the building cost 10x the rent. It's cheaper to maintain "productive air" than hire more employees.

High CO2 content makes people slow. As companies are able to monitor and measure air quality attributes, we're learning more about how VOCs, particulates and other harmful contaminants negatively affect human performance, cognition and generally reduce well-being. You can't manage what you can't see. High performance smart buildings provide the tools necessary to actively watch what's going in buildings.

Next Steps

At Cinch IoT we're committed to helping companies optimize building operations, reduce costs and improve the safety, health, comfort and

[2] Associations of Cognitive Function Scores with Carbon Dioxide, Ventilation, and Volatile Organic Compound Exposures in Office Workers: A Controlled Exposure Study of Green and Conventional Office Environments | Environmental Health Perspectives | Vol. 124, No. 6 (nih.gov)

productivity of building occupants. If you still have questions, call us, we're happy to have a conversation about how we can help you. Our team has worked on hundreds of smart building projects with many of the leading architects, designers, engineers, technology consultants, GCs and EC's in the world. No matter where your project is located, we can find the right people and partners to help. Cinchiot.com