The Benefits of Air Quality Sensors in Building Management

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Could air contaminants affect our health?

Good air quality in buildings is vital for people who spend much of the day indoors. We spend an average of 90 % of our time indoors, more than 20 hours in enclosed spaces. We breathe in almost 400 million litres of air in a lifetime to provide sufficient oxygen to stay alive. Indoor air quality does affect our health and therefore, badly managed air quality can have economic and legal implications.

- **Pollutants can cause or contribute to short and long-term health problems, including asthma, respiratory tract infections and allergic reactions etc.**
- **Indoor air pollutants can cause discomfort, increase absenteeism and reduce productivity.**
- **Poor indoor air quality strains relationships among employees, family members, teachers and students.**
- **Indoor air quality problems can result in litigation.**

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What can contaminate the air we breathe?

There are many sources of indoor air pollution in buildings. Occupants of a building are the main source of carbon dioxide and volatile organic compounds (VOCs) are emitted as gases from certain solids or liquids. Carbon dioxide is exhaled as a byproduct of living processes. People in the office environment exhale carbon dioxide at a rate of about 0.3 l/min when performing light office duties. VOCs include a variety of chemicals (for example formaldehyde), some of which may have short and long-term adverse health effects. Concentrations of many VOCs are consistently higher indoors (up to ten times higher) than outdoors. VOCs are emitted by a wide array of products numbering in the thousands. Examples include paints and lacquers, paint strippers, cleaning supplies, pesticides, building materials and furnishings, office equipment such as copiers and printers, adhesives and marker pens.

Carbon dioxide is not generally found at hazardous levels in an indoor environment. It is, however, often measured when trying to determine the indoor air quality of a building. It is a good surrogate measure of how well the ventilation system is working in relation to the number of occupants. If the levels of carbon dioxide are high, it is assumed that there may not be adequate ventilation into the area and this in turn may allow for the build-up of other indoor pollutants. Inadequate ventilation can definitely increase indoor pollutant levels by not bringing in enough outdoor air to dilute emissions from indoor sources and by not transferring indoor air pollutants out of the building.

How are these contaminants removed?

Mechanical ventilation systems in large buildings are designed and operated not only to heat and cool the air, but also to draw in and circulate outdoor air. If they are poorly designed, operated, or maintained, ventilation systems can contribute to indoor air problems in several ways. For example, problems

arise when, in an effort to save energy, ventilation systems are not used to bring in sufficient amounts of outdoor air. Inadequate ventilation also occurs if the air supply and return vents within each room are blocked or positioned in such a way that outdoor air does not actually reach the people occupying the building. Improperly located outdoor air intake vents can also bring in air contaminated with automobile and truck exhaust, boiler emissions, fumes from dumpsters, or air vented from restrooms. Finally, ventilation systems can themselves be a source of indoor pollution by spreading biological contaminants that have multiplied in cooling towers, humidifiers, dehumidifiers, air conditioners, or the inside surfaces of ventilation duct work.

Could improving the air quality in buildings save you money?

Buildings consume at least 40% of the energy we use in most countries. The absolute figure is rising fast, as construction booms, especially in countries such as China and India. It is essential to act now because more efficient buildings can make a major contribution to tackling climate change and energy use.

The latest vision is a world in which buildings consume zero net energy. Examples exist of where this target is being considered achievable. For instance, the UK government anticipates dramatic energy reductions by users to achieve its goal that all new homes in England will be carbon-neutral by 2016.

Work over the next few years will focus on "zero net energy" building designs. We all recognise that sustainable buildings are important for the environment but underestimate the contribution that the emissions from buildings make to greenhouse gas levels - about 40%.

Progress on improving performance can begin immediately. Knowledge and technology exist today which can dramatically reduce the energy buildings use, while at the same time improving levels of comfort.

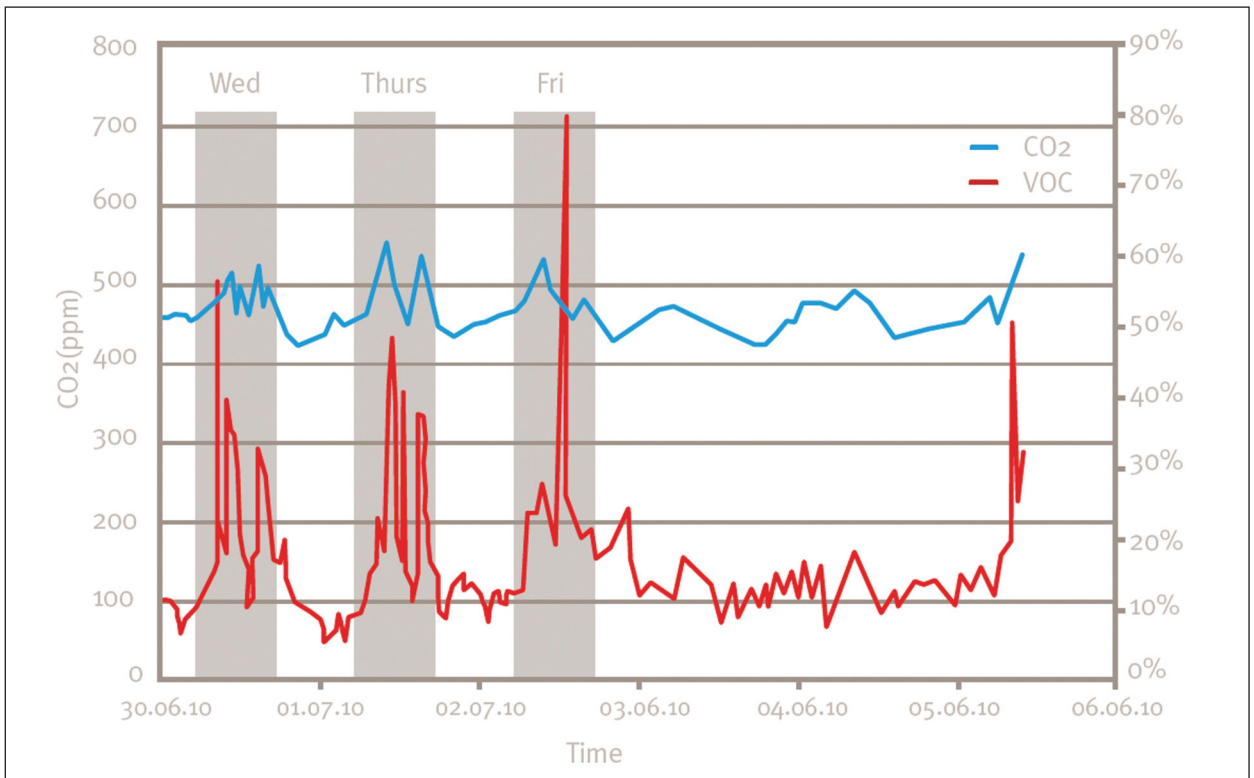
Building efficiency depends not only on the performance of individual elements but also on how they perform as integrated systems. The building envelope is particularly important. It is the starting point for energy efficient buildings and the main determinant of the amount of energy required to heat, cool and ventilate.

What solutions are on offer?

e2v has mastered two technologies able to monitor the air quality levels in buildings.

e2v manufactures a range of Infrared (IR) and Metal Oxide Semiconductors (MOS) gas sensors for a variety of gases and vapours in different applications.

e2v's IR sensors are compact and robust gas diffusion type sensors. They operate at low power levels and use well proven Non-Dispersive Infrared (NDIR) detection methods. They are currently ruggedly built using single active gas channel detection for economy and are best used in areas where monitoring is required. Typical applications include: CO_2 monitoring in confined spaces, indoor air quality, respiratory monitoring, and school science experiments.



e2v sensors can monitor the presence of most air contaminants in a building 24 hours a day

e2v also manufacture a wide range of metal oxide semiconductor (MOS) gas sensors.

For the detection of VOCs, the sensing layer is usually composed of a metal oxide and is heated. When chemicals are absorbed on its surface, its electrical conductivity changes locally; this leads to a change in its electrical resistance. MOS gas sensors are more complex than other sensors because they combine thermal, chemical and electrical effects. e2v MOS sensors have proved to be sensitive to most of the VOCs present in the air.

In addition to this, the heater element of the MOS sensor has been adapted to surpass usual bulb emitters (used in IR sensors) in both power consumption and reliability. Our MEMS heater emits IR in a wide range of frequencies and is well suited for the CO_2 absorption wavelength. Such emitters offer long term reliability and are maintenance and calibration free with low power consumption and a great potential for custom integration.

Using its' IR and MOS sensor technology. e2v has demonstrated an ability to monitor the presence of most air contaminants in buildings, 24 hours a day.

What benefits do e2v sensors provide?

What happens when activities in buildings are reduced and VOC/CO_2 production is lower? Most of the time, ventilation systems remain in normal use and consume the same amount of energy. Monitoring air quality with e2v CO_2 and VOCs gas sensors allows a dynamic multi-zone ventilation equation in which a CO_2/VOCs-based dynamic occupancy detection scheme is employed. This strategy can be implemented in an independent Intelligent Building Management and Integration platform, which communicates with the main station of the Building Management System through a communication protocol and interface.

The performance of this dynamic ventilation strategy has been tested in practice and validated by comparing it with the original fixed outdoor air flow rate control strategy used on-site.

The graph indicates the level of CO_2 (in blue) and VOCs (red) detected.

Several situations can arise. For example in shopping centres where the background level of VOCs is low and there is no activity at night, the sensor can reduce the rate of air exchange to a minimum and reduce energy consumption, or even close down the ventilation system. In addition, should the level of VOCs remain high due to the presence of building materials and furnishings, or people using cleaning products, air quality sensors can adjust the rate of air exchange to ensure correct air quality standards are maintained.

Some tests have shown that it is possible to reduce the systems operating time by 20 to 25% while significantly improving air quality in enclosed areas. In new buildings, energy saving can be increased to 30-40%, sometimes up to 60%. Lower consumption not only reduces electricity bills but also decreases the impact on climate change while improving air quality and people's health.

e2v will work with you to develop a customer Air Quality Monitoring methodology employing a combination of sensors to meet the requirements of your building control system.