CO_2 Detection Technologies

The air is 'foul, odorous and pestiferous', so described was the air of the English Parliament in the 18th century. Later, after parliament had burned down, a commission was made to try and calculate how much air should be introduced to ventilate the members, and so began the requirement for indoor air quality.

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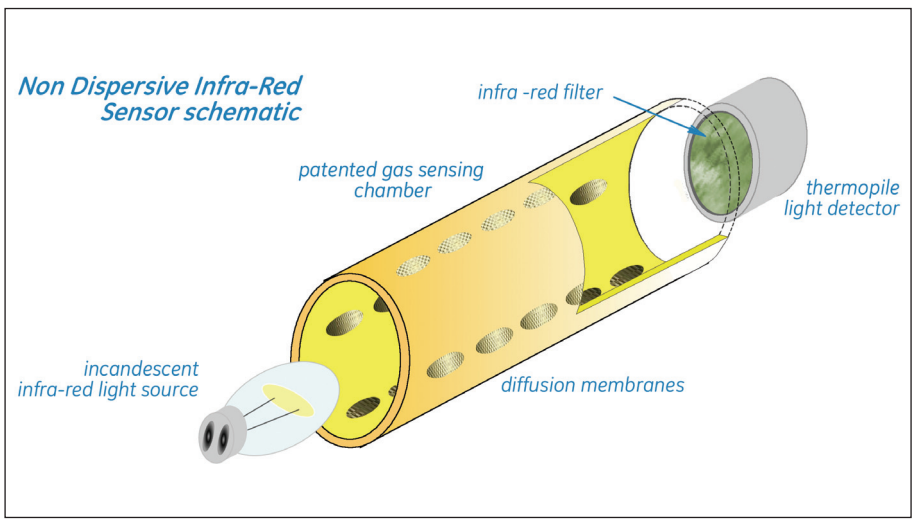
Thus, early in the 19th century, a figure of just less than 2 liters per second per person was determined by the legislators to keep the seat of government 'fresh'; since then requirements have moved on and current thinking leans toward 10 liters per person per second to maintain air quality in a typical work environment, such is progress.

As the primary source of contaminant, humans exhibit the attribute of expelling CO_2, thus providing a measurable solution to vary outside air dilution rates. But why vary outside air volumes? Today we are faced with ever increasing pressure commercially and by legislation to reduce energy requirements; and outside air is typically the most expensive air to heat or cool, so minimizing it reduces energy usage. The use of CO_2 to measure occupancy rates and air quality is well documented, ASHRAE have a number of papers and studies showing its validity. This article discusses the various technologies available to measure, and thence control, CO_2 concentrations.

The methods for measuring CO_2 have been known for quite some time, but the devices used required frequent calibration, were difficult to manufacture, and as such were very expensive. The first low cost CO_2 sensors, designed specifically for the ventilation market, were introduced in 1990. These too suffered long term drift and were subject to annual calibration if meaningful output was required; so although 10% of the cost of their metrology counterpart, their usage remained infrequent.



The pace of micro-electronics, and the accuracy of production has improved, so we now have CO_2 sensors that not only are less costly, but do not have any requirement for recalibration to stay within acceptable tolerances - both attributes entirely suitable for the HVAC controls market. Fortuitously they have become available as legislative and regulatory change forces designers to measure, and vary ventilation rates based upon occupancy levels.

A number of technologies can be used to measure air quality, but those in common use are outlined below.

Volatile Organic Compound Sensor:

Uses an interactive plate, where the capacitance or resistance of the plate varies according to the level of contamination of the plate by volatile organic compounds. The plate is heated to burn off contaminants at a preset rate, and so air quality is measured. By selective application of chemicals to the oxidising plate gas selection can be improved; but the output remains largely subjective. The VOC sensor is susceptible to over contamination and degradation, although the cost of the component is very low. The degradation can be likened to a non-stick pan running out of non-stick.

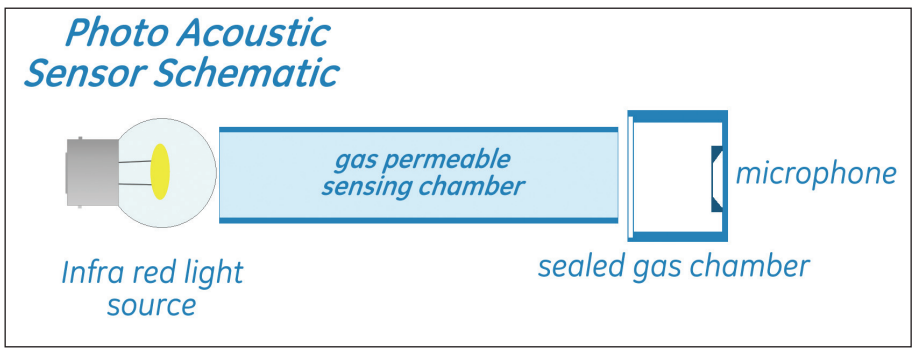
Non-Dispersive Infrared Detection (NDIR):

Spectral analysis of gases shows that different gases absorb infrared energy at specific and unique wavelengths in the infrared spectrum. Non-Dispersive Infrared Detection (NDIR) looks for the change of light level that occurs at the wavelength where CO_2 absorption takes place. The light intensity is then calibrated to CO_2 concentration. Figure 1 provides an example of a typical NDIR sensor where ambient air is allowed to diffuse into the chamber that contains a light source at one end and a light detector at the other. A selective optical filter is placed over the light detector to only admit light at the specific wavelength where CO_2 is known to absorb light.

To overcome the corrections needed for component ageing and any particulate contamination long term sensor stability is achieved in a normal HVAC environment by having the sensor self calibrate. When the space is unoccupied the CO_2 is assumed to fall to ambient levels at least 3 times within any 2 week period. These values are averaged on a rolling basis, and this value used as the new baseline. Exhaustive testing by Telaire has shown the process valid and that sensors so equipped will remain within tolerance for their lifetime.

If the measured space is occupied 24 hours / 7 days per week then obviously the self calibration will not function, in this case a slightly more expensive solution is required, the dual beam approach. Here a second light detector is tuned to a wavelength with no gas absorption and thus becomes a reference for the measuring detector.

Particulate build up is reduced by fitting a filter that blocks dust, but still



allows gas to permeate through and diffuse in the sensing chamber.

Photo-Acoustic CO_2 Sensors:

The final technology under discussion is photo-acoustic sensing, and arguably the future of CO_2 sensing. This type of sensor uses a chamber open to the atmosphere and exposes air in the chamber to flashes of infrared light specific to the gas absorption wavelength for CO_2. This flashing light causes the CO_2 molecules to vibrate as they absorb the infrared energy, the vibration is monitored by a microphone and microprocessors calculate the CO_2 concentration. Figure 2 shows a schematic of a photo-acoustic sensor. This type of sensor is not as sensitive to dirt and dust but can be affected by the same light source aging characteristics of NDIR sensors. A crucial difference is the sensor measures the light absorbed by the sample. This is in contrast to conventional NDIR, which measures the light not absorbed. Since photometric error is eliminated, very sensitive detection is possible. Photo-acoustic sensor accuracy can also be affected by vibration and atmospheric pressure changes. More accurate sensors often will use a pressure sensor to correct for the range of pressures found in HVAC measurement applications. This type of sensor is currently difficult to manufacture in large volumes, and consequently not in widespread use.

Looking to the future all manufacturers are looking to make their sensors smaller, more cost effective, more accurate, and less power hungry. As such they continue to better production techniques, as well as research new technologies. In time this will enable the technology to be utilised in wireless systems, and combined with other ventilation sensors for more cost effective installations.

AUTHOR DETAILS

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About the author:
Neil Roberts is EMEA Products Specialist for the Telaire range with GE Sensing.

Neil Roberts has worked in the building services environment for over 20 years. He has an in depth knowledge of advanced control applications based on extensive experience of theory and practise. Pragmatic and tenacious, he has resolved control issues and advised services consultants on practical control solutions. Currently with the Telaire group of GE Sensing, he supports the sales leaders across Europe, Middle East & Africa on the CO_2 and building automation sensor range.

New Generation of CO_2 Transmitters

GE Sensing —Telaire (Germany) release a new generation of CO_2 transmitters targeting indoor air quality and energy conservation applications. The Ventostat® T8031 / T8041 Duct Mount and the Airestat® T5000 Series Wall Mount CO_2 Transmitters offer accuracy and versatility at an affordable price. This exceptional product line touts an unobtrusive form factor that is easy to install, simple to use, and remains accurate over the expected life of the device utilising Telaire's patented ABC Logic™ (Automatic Background Calibration) technology.

"The new Telaire CO_2 Transmitter product line represents a marked improvement in size, ease of use, and customer installation," says Dave Michels, Global Product Marketing Manager for Telaire Products. "We listen to our customers and deliver innovative solutions."

The technology is based on the absorption of light in a gold-plated reflective light pipe or waveguide diffusion gas chamber. A gas permeable Teflon filter prevents particulate and water contamination of the sensor. Light is absorbed in proportion to the CO_2 concentration and the remaining light is measured and converted into an analog signal. The Telaire product line offers patented ABC Logic™ - software for self-correction of drift to better than ±20 ppm per year. The system is virtually free of maintenance and typically has a lifetime of more than 10 years. CO_2 transmitters can be utilised in a broad range of applications including Air Quality monitoring in buildings. CO_2 concentration levels in buildings are monitored to provide an indication of occupancy and to drive a ventilation control strategy. An effective DCV (Demand Controlled Ventilation) strategy will conserve energy and maintain indoor air quality. The new Ventostat® T8031 Duct Mount CO_2 Transmitter is one of the smallest in-duct CO_2 sensors on the market! Take advantage of this modest form factor to accommodate small diameter (6") HVAC return air ducts or utilise the T8041 Duct Mount Probe to measure CO_2 concentrations in larger air ducts. Both products offer a standard analog 0 to 10 volt output, mounting hardware, and simple mounting instructions. The Airestat T5000 Series Wall Mount CO_2 Transmitter offers user definable thresholds and a visual limit LED indicator (green, yellow, & red) for measured CO2 concentrations. The T5000 series also provides a passive temperature and a standard analog 0 to 10 volt output. This device is an essential tool for maintaining an indoor air quality strategy for school classrooms, offices, and many other applications.

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Newly Redesigned Test Ventilation and Indoor Air Quality Line of Products

TSI (UK) is proud to launch a newly redesigned line of anemometers and indoor air quality instruments. The new products provide highly accurate, fast, and easy to use instrumentation for serving building service contractors, commissioning specialists, facility engineers, and research professionals.

The new thermal anemometers come with intuitive operation and a large display to view measurements. Enhanced features include LogDat2, an easy to operate software package that simplifies data logging and reporting. Downloading data through USB has increased speed and wireless Blue tooth printing enables onsite printing to an optional portable printer.

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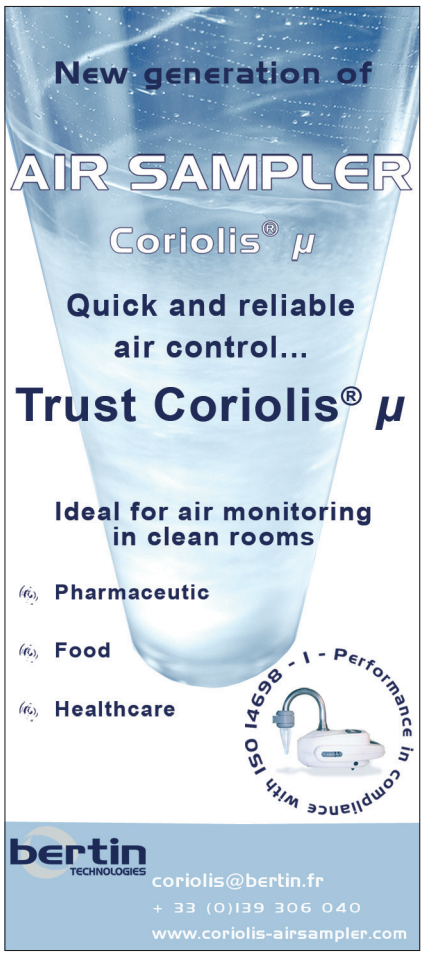

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