AirTest™
Sensors That Make Buildings Smart!

CO_2 Control In School Classrooms

Why Consider CO_2 Control

There are four primary reasons to consider using CO_2 sensors in school classrooms.

1. Student Health Considerations

CO_2 monitoring can ensure that acceptable levels of ventilation for the health and welfare of students and teachers is maintained at all times.

- ***Are Codes & Standards Being Met?*** CO_2 levels can provide a direct indication of the CFM per person ventilation rate in school classrooms and can provide an ongoing indication if code required ventilation rates are being maintained. As a result, readings can immediately indicate problems and historical records of concentrations can be used to document acceptable performance of the ventilation system. CO_2 sensors are much more cost effective than active airflow monitoring of outdoor intakes.

- ***Poor Ventilation Can Contribute to Absenteeism & Poor Student Performance*** There are now numerous scientific studies that document that the lack of proper ventilation can impair student performance. Poor ventilation can also increase the effective spread of viruses that lead to increased absentee rates which in turn may directly affect school operational funding. For the latest studies on schools and ventilation go to: http://eetd.lbl.gov/ied/sfrb/vent-school.html. The value of CO_2 measurements is that you can constantly monitor and control ventilation levels to ensure student health and productivity.

2. Moisture Control:

The US EPA Tools For Schools program, which is used by schools throughout the country, recommends CO_2 control can be used to significantly reduce moisture loading in schools particularly during summer months due to the introduction of humid outside air. According to the US EPA:

> *Summer breaks often end with significant mold problems in schools, not only in the southeastern U.S., but in most states east of the Rockies. This is due to several factors: higher humidity in the outdoor air during the summer; lack of cooling system operation because school is out; and extra indoor moisture due to special activities such as deep cleaning of carpets and painting. These conditions do not need to exist for the whole summer before expensive mold remediation and clean-up is required - only a couple of weeks can result in cleanup costs ranging in the tens to hundreds of thousands of dollars. Therefore, moisture control during summer break, even if the building is not occupied, is essential.*
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> *The energy management system could be set so that in the summertime, carbon dioxide (CO_2) sensors in each zone control the outdoor air damper for that zone. If background (outdoor) CO_2 levels are detected, dampers would remain closed. However, if elevated CO_2 levels occur, indicating occupancy, dampers would open until the CO_2 levels return to background levels. Use of such a demand controlled ventilation system in these circumstances can help ensure that potential mold problems are significantly reduced, energy costs are reduced, and occupants are protected - all automatically - using current CO_2 technology that is inexpensive, easy to install, and self-calibrating.*
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> *Link For Further Information: http://www.epa.gov/iaq/schooldesign/moisturecontrol.html*

3. Energy Savings & Greenhouse Gas Reduction:

CO_2 sensors have been shown to be very important to ensure overall optimum building performance at all times and can contribute to lower energy costs and reduced greenhouse gas emissions. It is for this reason that the US Green Building Council (www.usgbc.org) includes CO_2 sensors as part of its LEED green building rating system. Many utilities and state energy agencies also offer rebates or other incentives for the installation of CO_2 sensors. CO_2 sensors can help reduce energy use in two ways, as explained below.

- **How Much Is The Right Amount Of Air?** The provision of outdoor air for ventilation in many climates represent the single most significant load for air conditioning systems in buildings. Ironically the amount of outdoor air delivered to buildings is seldom monitored or controlled. Often a damper is adjusted to a fairly arbitrary level, and assumed to be correct to provide adequate ventilation (15 cfm/person at design occupancy). However the relationship between damper position and airflow is highly variable depending on the equipment used. Most dampers also regulate airflow exponentially to their physical position. For example, a 20% open damper position could result in 40 -60% outside air being delivered by the air handler. This amount of over-ventilation would represent a significant additional and unnecessary energy cost.

  CO2 Sensors will automatically regulate fresh air delivery so that over-ventilation does not occur. In fact, if fresh air is being delivered from another location such as an open window, hallway or another unoccupied classroom, the sensors will react to this source of fresh air and adjust the ventilation rate accordingly.

  CO_2 control is also an ideal way to control ventilation based on occupancy for large areas that may have intermittent and highly variable occupancy like cafeterias, gyms, auditoriums, multipurpose rooms.

- **Impact Of Variable Occupancy?** CO_2 based ventilation control is very good at modulating ventilation based on actual occupancy. In some cases, the thought is there may not be a great opportunity to save energy because classrooms at a particular school are always full. However in many cases classrooms may be subject to variable occupancy for the following reasons:
  - Lunch hours, recesses and staggered classroom hours may cause unoccupied periods.
  - Night school or other after hour activities may not result in the same densities that occur through the day in all classrooms.
  - Field trips, assemblies, teacher days and other events may cause a classroom to be unoccupied for a one to three days per month that may not be accounted for in automated operational schedules.
  - Classrooms may be near full but even a classroom that is 80% full can reduce ventilation costs with CO_2 controlled ventilation.

  All of these conditions can lead to enough variability where the use of CO_2 sensors makes sense both by reducing over-ventilation and by modulating ventilation based on occupancy. Energy analysis programs are available that can estimate the impact of even minor variation in occupancy on energy savings. Contact Airtest if you would like more information on estimating energy savings from CO_2 controlled ventilation.

Implementing CO_2 Control

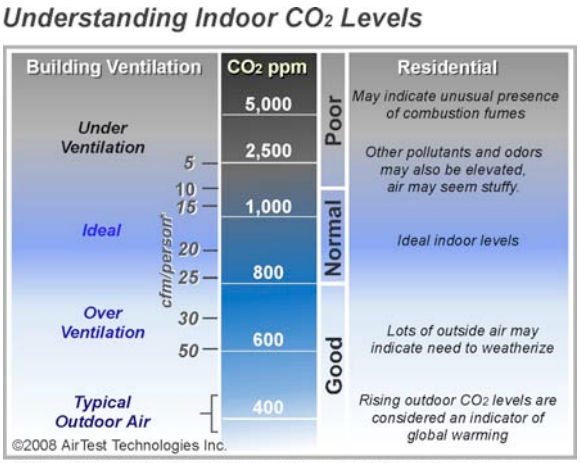
Demand Controlled Ventilation using CO_2 sensors is now a common method of ensuring a building is providing cost-effective ventilation while maximizing indoor air quality. It also is seen as an ideal continuous monitoring tool because CO_2 readings will almost immediately indicate unusual levels if equipment is broken or malfunctioning. In fact most building control systems, packaged rooftop systems and unit ventilators built in the past 5-7 years can accept CO_2 sensor inputs. This means that the cost of implementation may be fairly low and could be performed by existing school repair and maintenance staff. AirTest offers a family of zero maintenance, self-calibrating CO_2 sensors that are compatible with all building control systems. To find out more about AirTest's CO_2 products click on this link: https://www.airtesttechnologies.com/product/co2-ventilation/index.html .

Why Measure CO_2?

It is important to note that CO_2 is not considered a contaminant or pollutant at the levels normally measured in buildings (400 to 2000 ppm). It is however widely recognized as an indicator of ventilation rates inside buildings. Certain levels of CO_2 indoors correspond to various cfm/person ventilation rates. The chart below shows this relationship.

CO_2 is about the only parameter that can actually measure the amount of fresh air that is being delivered to a space based on its occupancy. As a result it is increasingly being used as a feedback control to ensure buildings are ventilated appropriately for their current occupancy. Otherwise outside air intakes are set based on what might be maximum occupancy. However over time air intake positions become arbitrarily, or improperly set. CO_2 control can save energy by modulating ventilation based on actual occupancy and can ensure that if something goes wrong or out of adjustment with the ventilation system, CO_2 levels will indicate a problem generally before people notice.

For more information on the theory behind CO_2 control and how it is applied you can download AirTest's CO_2 Reference Guide, which provides links to a number of articles on CO_2 for ventilation control: www.AirTestTechnologies.com/docs/co2/CO2Reference.pdf .



Note: Interpretation should be based on peak CO2 readings in a space.

Installation Guidelines

- Sensors should be installed on the wall in each major occupied zone (e.g. classroom). Placement in return ductwork is not recommended for two reasons:
  1. If a return air duct serves a number of spaces, the CO_2 concentration in the duct will reflect the average of all spaces being ventilated and will not indicate the actual ventilation rates being experienced in each space.
  2. Ceiling return air plenums often also have supply air ducts that provide cooling and heating to the space. If these ducts are leaky, they can dilute CO_2 concentrations in the return air so that the CO_2 levels will not be indicative of what is really happening in the space.

  In very large spaces like gyms, auditoriums and multipurpose rooms one sensor should cover approximately 5,000 to 7,000 square feet. If multiple air handlers serve the space, one approach is to connect a CO_2 sensor to each air handler.
- Where one air handler serves multiple spaces, the outside air should be controlled off the sensor in the zone with the highest CO_2 concentration. There are inexpensive transducers available that can take multiple sensor inputs and past through the highest level to an air handler or damper control. Most building control systems can also perform this function.
- Placement criteria for sensors are similar to that of thermostats, however they can be mounted higher or lower with no impact on sensor sampling accuracy. Areas that should be avoided are areas near doors or windows, or in areas where people are likely to be standing and breathing on the sensor.
- The typical control strategy is to modulate outside ventilation as CO_2 levels rise in the space. This type of control will keep CO_2 levels below 1,000 to 1,100 ppm. To see a sample control strategy click here: www.AirTestTechnologies.com/support/reference/CO2SeqOfOperation.pdf

AirTest CO_2 Sensors In Schools

Thousands of AirTest CO_2 sensors have been installation in school districts throughout the US and Canada. AirTest is known for its zero maintenance, self-calibrating sensor. If you are involved in a school project and would like to talk to another district facilities manager or contractor who has used AirTest CO_2 sensors in their project, please contact AirTest at 888-855-8880 for references. Also visit the Case Study section of our web site that includes a few school examples: www.AirTestTechnologies.com/company/casestudy/index.html

Further Information:

- AirTest CO_2 Products For Building Control: www.airtesttechnologies.com/product/co2-ventilation/index.html
- CO_2 Engineering Specification: www.airtesttechnologies.com/support/engineering-spec/tr9290guidespec.doc
- Portable CO_2 Monitors: www.airtesttechnologies.com/store/air_quality_monitors_and_diagnostic_tools.php
- AirTest CO_2 Reference Guide: www.airtesttechnologies.com/docs/co2/CO2Reference.pdf

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