Veris Application Note

Measuring CO_2 Levels in Schools

Introduction

One important factor when providing for the health and well-being of students is the level of carbon dioxide (CO_2) present in classrooms. Typical outdoor CO_2 levels are around 400 ppm. Due to human respiratory activity, indoor levels are higher than this, at approximately 600 to 800 ppm. Over time, in occupied spaces, this level can increase to 1000 ppm or more, leading to symptoms such as headaches, drowsiness, and difficulty concentrating. In children, this effect is exacerbated because they breathe a larger volume of air in proportion to their body weight, as well as the fact that classrooms are often more densely populated than office spaces and multi-use buildings. Numerous scientific studies show correlations between poor ventilation and poor student performance.

Demand Control Ventilation

CO_2 monitoring and Demand Control Ventilation (DCV) offer an efficient solution to the buildup of CO_2 in classrooms. DCV works by continuously monitoring interior environmental conditions and adjusting the ventilation to maintain proper indoor air quality.

Accurate environmental monitoring is crucial for a good DCV system. Sensors continuously measure CO_2 levels, temperature, and humidity, and send this data to a control system. The data presents a complete picture of the indoor environmental quality over time. The control system is programmed with threshold levels for CO_2, temperature, and humidity, and it triggers the ventilation system when any of these values are out of acceptable range.

In a CO_2-based DCV system, the control system looks at CO_2 levels, rather than temperature or humidity, to drive ventilation activity. In this way, human occupancy throughout the day determines how much ventilation is needed. As long as CO_2 levels are within preferred limits, only interior air is circulated. When CO_2 levels increase beyond an established threshold, the ventilation system draws in outside air to correct this. Since the thermal conditioning of outside air increases costs associated with the HVAC system, it is more efficient to perform this step only when necessary, rather than following some fixed formula, such as time-controlled programs. DCV, therefore, helps to lower energy costs for the building.

Special DCV Requirements in School Buildings

Unlike a large, open office building, whose HVAC requirements are often uniform throughout the space, a school contains areas with radically different needs. Consider a school building that includes numerous classrooms full of students all day, a large auditorium that is only used for certain assemblies, and an office area with a small staff. To maximize overall efficiency of the HVAC system, these zones must be treated differently.

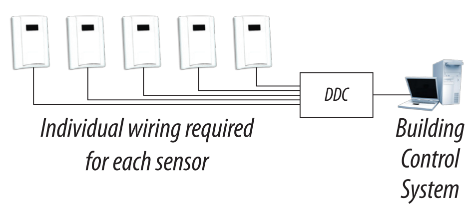
Because of the special needs of schools, many school districts are passing regulations requiring a CO_2 sensor and independent DCV for each room. This maintains safe and healthy air quality in occupied rooms, and it increases overall energy efficiency by reducing ventilation in unoccupied or sparsely occupied areas.

CO_2 Sensor Installation Strategies

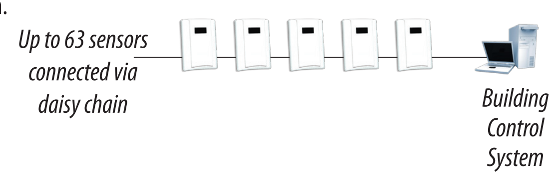
CO_2 sensors based on non-dispersive infrared technology provide highly accurate readings, with no drift over time. The sensor contains an infrared source, and CO_2 concentrations are calculated by measuring the absorption of infrared light by the ambient air. This absorption is proportional to the ppm CO_2 present.

In a school, sensors are mounted on walls so that readings are specific to the room. If sensors were installed in ducts, the readings would represent an average of all rooms served by that duct, rather than giving real time information about an individual area. Sensors should be mounted away from doors, windows, and other sources of draft that might create an artificially low reading.

In conventional HVAC systems, sensor data travels to the building control system via a direct digital controller (DDC). Each device is wired to the DDC individually. If CO_2 sensors are required in every classroom of a school building, this increases the labor cost. Additionally, the amount of wiring needed takes up substantial space in already crowded conduits.



One way to reduce installation costs is to use a CO_2 sensor equipped with a protocol communications capability, such as BACnet. Protocol sensors are connected to each other in a daisy-chain fashion, with only the first device in the chain connecting to the control system. The DDC is no longer needed. This dramatically reduces the amount of wiring, labor, and space required for the HVAC system.



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Combination Sensor Advantages

CO_2 combination sensors allow a building administrator to monitor additional critical indoor environmental quality parameters, such as temperature and humidity. These combination sensors lower acquisition and installation costs because one device does the job of three. Also, with protocol communication, they increase the building control system capacity, because all environmental data for a room is collected using a single BACnet address.

Added Benefits of CO_2-Based DCV

A CO_2-based DCV system can bring a facility into compliance with building standards. ASHRAE Standard 62 recommends a ventilation rate of 15 to 20 CFM to maintain adequate indoor air quality conditions, and ASHRAE Standard 90 requires CO_2-based DCV in densely occupied spaces.

US Green Building Council's LEED program has a special ratings system just for K-12 school buildings. Indoor Environmental Quality Credit 1 (Outdoor Air Delivery Monitoring) awards points for a CO_2-based DCV system capable of triggering an alert or a corrective action when CO_2 levels vary by more than 10% of established values for the building.