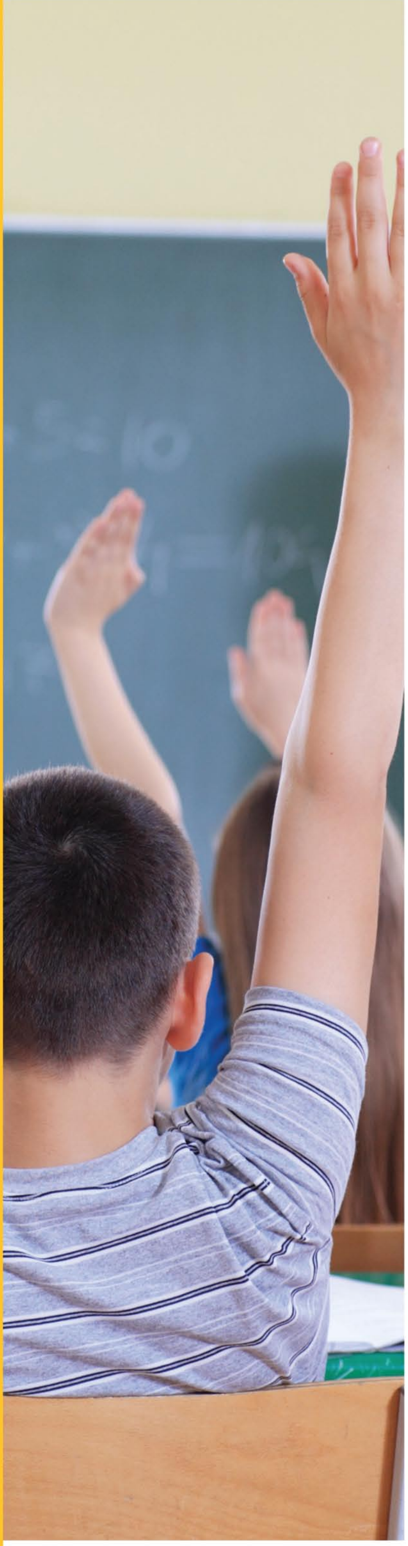
Lessons in how to create the right atmosphere

Increasingly airtight school buildings can lead to a build-up of carbon dioxide in classrooms which can affect the concentration of pupils. However, ventilation systems incorporating carbon dioxide monitors can be designed to provide optimum indoor air quality to keep the children awake, says Chris Dearden, managing director of Medem UK



CARBON DIOXIDE (CO_2) levels in rooms are recognised as a key indicator of the general indoor air quality of a building. For a medium quality of indoor air, CIBSE recommends a CO_2 concentration of no more than 900ppm to control human odours and maintain comfort.

However, CO_2 levels in school classrooms in a number of UK schools have been found to be above 4,000ppm with ventilation rates of less than 0.5l/s per person in some classrooms.

This is important because higher levels of CO_2 reduce the attention span of students so they are more likely to lose concentration and this may affect their ability to learn.

The problem has been exacerbated as building air-tightness standards have improved and infiltration ventilation rates in both new and refurbished educational buildings have reduced. In many ways, this is a good thing – after all, reducing energy consumption is a major part of sustainable building design.

However, it has also led to a rise in CO_2 levels in occupied areas such as classrooms.

Effective ventilation

This, in turn, has increased the need for effective ventilation. Indeed, monitoring internal CO_2 levels and adjusting heating and air conditioning ventilation rates depending on the occupancy level is a tried-and-tested method of minimising a building's energy use.

A key reference for this area is *DfES Building Bulletin 101 – Ventilation of School Buildings.*

It states that the ventilation should be provided to limit the concentration of carbon dioxide in all teaching and learning spaces so that when it is measured at seated head height, during the continuous period between the start and finish of teaching on any day, the average concentration of CO_2 should not exceed 1,500ppm.

This requires that at any occupied time, including when teaching, the occupants should have the ability to lower the CO_2 concentration to 1,000ppm (by extra ventilation). CIBSE TM40 also recommends a limiting value of around 1,000ppm.

Installed systems based on ventilation standards such as CIBSE Guides A and B provide rates of ventilation assuming continuous occupancy. This can mean unnecessary energy consumption can occur, particularly in education buildings where the occupancy in classrooms will vary during the day.

The principal options are natural, mechanical or mixed mode ventilation. Whichever method is used, it is possible the metabolic thermal gains from high classroom occupancy will often compensate for any thermal losses in a modern building even during winter.

So the system must be flexible enough to benefit from the casual gains in winter, remove the heat load in summer and maintain an appropriate air quality.

Naturally-ventilated schools are reasonably common in the UK, but pressure on space and location frequently dictate some mechanical ventilation. The wide deployment of advanced building modelling tools has enabled designers to meet performance standards in the designs while appropriately exploring the use of an automatic natural ventilation system employing CO_2 sensing.

Mixed mode systems are frequently used to minimise the operational costs of the mechanical ventilation systems. Mixed mode ventilation uses natural airflow through the building whenever possible, but the classrooms where it is considered necessary can be fitted with additional mechanical systems to increase the ventilation rate when needed.

The ventilation rate in each room can be designed so that it depends on the occupancy level. During the day, the occupancy of classrooms is likely to vary. By incorporating CO_2 monitoring into the ventilation system design, the ventilation rate can also be varied to ensure the correct amount of air changes for the conditions.

This can be achieved by the carbon dioxide monitor controlling the operation of the fans to keep the CO_2 level in the classroom below the level of 1,500ppm. Or it could simply be through the use of a traffic-light system which provides a visual indication of CO_2 levels so that staged ventilation can be manually switched.

Total cost and carbon

By analysing the likely scenarios in the occupied space, the systems can be evaluated for total cost and total carbon while still ensuring the final systems maintain acceptable air quality. Where demand-led ventilation systems are used, heat recovery within the mechanical extract system may cease to be cost effective. However, remember many indoor air pollutants are generated independently of occupancy (for example, VOCs from carpet off-gassing and stored materials and air from contaminated spaces).

Where pollutant sources are independent of occupancy, CO_2 may not be a useful means of evaluating indoor air quality.

In schools, higher ventilation rates will be required in food technology rooms as well as other technology rooms where pollutants are likely, such as from brazing hearths and woodworking machines, that are independent of the occupants.

Casual equipment use, such as Bunsen burners, can increase the carbon dioxide levels in the space since a Bunsen burner will produce about double the carbon dioxide produced by a student or teacher. Therefore, a higher ventilation rate may be necessary in science laboratories.

Indeed, it is now common practice to install gas pressure proving systems in school laboratories and these systems are now available with integrated carbon dioxide monitoring to control the ventilation rate.