Indoor Climate Control

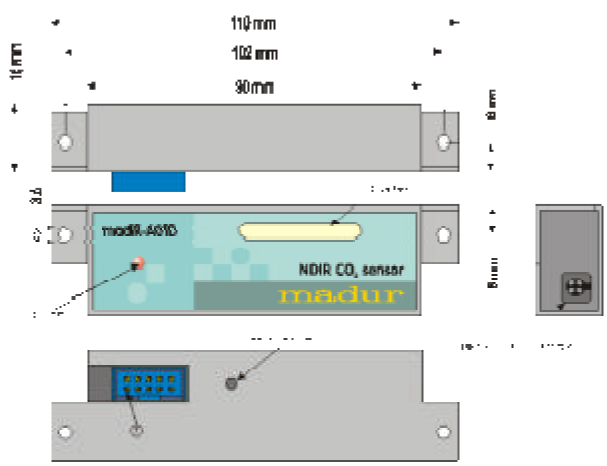
The European Perspective

For many years now, heating systems have been standard in all office buildings in the temperate or cold regions. Air conditioning is now common in many areas, and ventilation is a requirement in all new buildings. This presents us with the problem of heating or cooling an environment, and ex-changing the air at the same time. Clearly, this will lead to a certain wastage of resources, and an improved indoor climate control is needed.

Much attention is paid to the correct temperature at the working area, but very little note is made of the quality of the air we breathe. Tests have shown that a carbon dioxide level of over 1000 ppm can lead to a loss of concentration of around 30 %. Not so terrible? Let's call it 3 from every ten employees on permanent paid sick leave, and it sounds slightly different!

Of course, you can always turn up the ventilation to maximum and try to compensate with a higher setting on the heating or air conditioning. Quite apart from the fact that a constant gale is not really a pleasant working climate, and will lead to numerous sick days for stiff necks and colds, the increased heating or air conditioning costs would be prohibitive.
Carbon dioxide is the simplest measure of occupancy for an enclosed space. Unoccupied spaces may need heating or cooling to keep the climate acceptable for future use, but they will not need much ventilation. Oxygen is not being consumed, carbon dioxide is not being produced, so why ventilate? This is the simple idea behind Demand Controlled Ventilation (DCV).

The infrared carbon dioxide sensors produced by madur electronics can be used to help regulate most modern ventilation systems. Programmable analog outputs are standard, which will connect to the control system without difficulty and allow the ventilation to be controlled according to the amount of carbon dioxide present.



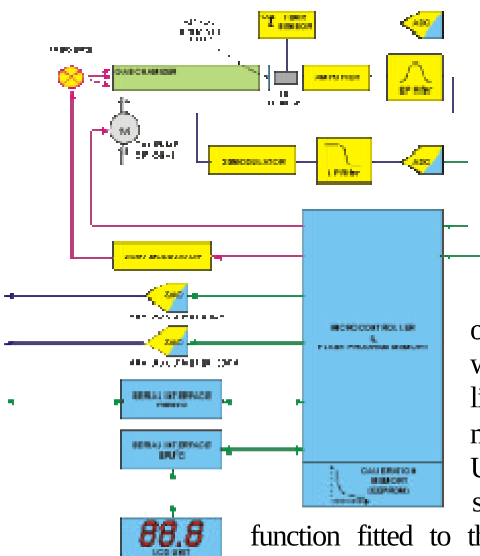
Unoccupied rooms will be ventilated until the preset level of carbon dioxide has been reached, then the ventilating system will return to a very low level, just enough to avoid the air becoming stale.
Control is solely dependent on the capabilities of the regulating system. It is quite possible, and indeed, with large buildings, essential, to control the ventilation for every room or tract separately.

A certain amount of thought should go into the placement of the sensors for indoor climate control. Their small size enables the site to be chosen completely freely. Putting them directly by the fresh air inlet is obviously somewhat counterproductive. They should be roughly where people are breathing the air, but far enough away from the people to avoid direct influences. An infrared sensor does not appreciate it if you breathe down its neck constantly!

One solution is to have a certain averaging time on the sensor, so the effects of somebody walking past the sensor and breathing 4 % carbon dioxide directly over it will not lead to an immediate tornado as the ventilation system tries valiantly to exchange the whole volume of air in next to no time! We have found that somewhere around 30 to 60 seconds provides a good compromise between reaction time and smoothing out the peaks.

Placing them directly by the air outlet is one possibility, but this will lead to longer reaction times and possibly unwanted cycling of the ventilation. Somewhere around head height, but at least 6' (2m) from the nearest person seems to work best for DCV systems.

So how does this work? This is not the place for a detailed description of the theory behind Non-Dispersive InfraRed technology. For those interested, the link will take you to some theoretical background about NDIR measurements and the various output forms available. In a few words, many compounds have a typical wavelength that is associated with their natural vibration. If light is shone through a chamber containing such molecules, then this particular frequency will be absorbed according to the number of molecules in the path. The pathway includes an optical filter to ensure that only the correct wavelength is measured. Other wavelengths will not pass the filter, which avoids the necessity of having a light source for a single wavelength. Basically, the more molecules are present, the more light will be absorbed. Unfortunately, this is not a linear function, so calibration of such sensors must be carried out at a number of points and a function fitted to the resulting curve. This is not a simple operation, but it can hopefully be automated in the future.

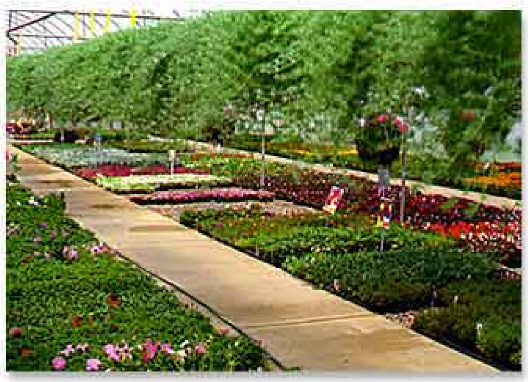


Indoor climate control using infrared CO_2 sensors for demand regulation has one simple drawback: It can only be used when the vast majority of the impurities in the air are produced by humans or animals. Water vapor is also produced during respiration and transpiration, but this is also proportional to the level of occupancy of the rooms, and can be considered as running parallel to the carbon dioxide. This is generally the case in large offices or conference rooms, but will not apply to a room full of printers or photocopiers, for instance. The modern trend, at least in Europe, is to segregate such equipment from heavily populated areas for the very reason that they *do* produce toner fumes and electrical fields, that may possibly be hazardous to health after long exposure. Such areas will require a simple permanent ventilation system, but cannot be included in areas regulated by demand.

Regulations vary between countries as to the volume of air that must be available to an office worker, and this will affect how the ventilation system will be organized. A larger volume will not reach critical levels of pollutants so quickly and provides a buffer, allowing the control of the ventilation to avoid sudden peaks of air-flow.

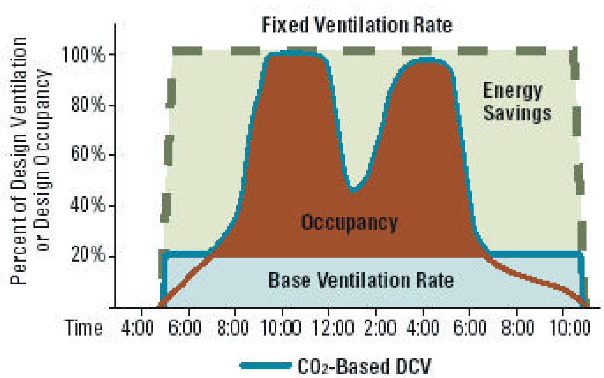
The other places which are predestined for demand controlled ventilation include mass farming in the meat or dairy sector. The animals are inside for many months at a time, at least in winter, and the ventilation here is critical. There is much less air available than is normally allowed for an equivalent mass of humans, and the animals have no possibility of influencing the ventilation on their own initiative. Poor ventilation in farm buildings can lead to slow ed growth or even asphyxiation of the cattle, as has repeatedly occurred here.

The second type of agricultural building is the greenhouse, where the opposite problem is to be found. Low levels of carbon dioxide will lead to slow or stunted growth of the crops. This can only be avoided by demand ventilation or adding of CO_2 to replace the gas absorbed during photosynthesis. The link will provide further information to this topic.



Now that the cost of sensor technology has been reduced dramatically and the fuel prices have continued their spiral upwards, energy conservation is no longer a matter for long-haired oddballs, but a matter of national survival in an industrial sense. Demand–controlled ventilation as a part of indoor climate control is one easy and essential step to a reduction in fuel consumption and hence fuel imports, and thus a step towards fuel self-sufficiency. This may well be an illus ory goal, but anything that reduces the overheads in industry helps to increase global competitiveness and safeguard the job market.

To sum up the matter: Demand-controlled ventilation is a very valid proposition in indoor climate control for all areas where the main source of pollutants is respiration, whether human or animal. DCV is also a legal requirement for new buildings in some European countries such as Germany. It cannot be used as sole control from zero to fully-open, there must be a small, permanent level of ventilation to ensure that the air is perceived as fresh after periods when the room is not occupied. This baseline ventilation can probably only be determined experimentally, but should not be left solely to the discretion of the occupants, who will probably set it to the highest level and leave it there! Having said this, the perception of air quality is very difficult to quantify, which is one of the factors that makes indoor climate control and DCV so difficult.



The quality of the air supplied by the ventilation system will have a major effect on the efficacy of a demand-oriented indoor climate control plan. If air is recirculated from other parts of the building, then this will naturally help with problems of heating or cooling, but will not help alleviate a high level of CO_2, since it will already carry a certain preload of carbon dioxide from other occupants. Fresh air admixture at the very least will be essential in DCV, the proportion dependent on the concentration of CO_2 present and the quality of the recirculated air, which can also be measured to ensure correct mixing.

Rooms with mostly non-respiratory sources of pollution will require a fixed level of ventilation and are not suitable for inclusion in the demand-controlled sectors. Buildings designed for animal husbandry and plant growth can also benefit greatly from DCV technology, and they were one of the first sectors to take advantage of indoor climate control, especially in the northern European countries, where animal husbandry is basically an indoor operation, and greenhouses are necessary for the less hardy plants.