AERECO

VENTILATING SCHOOLS

COMBINING ENERGY EFFICIENCY AND INDOOR AIR QUALITY

Schools and Classrooms:

variable occupancies and various configurations

In schools and classrooms, occupancies vary in levels and types. One must carefully choose the most adapted ventilation system in each case.

Schools usually include various types of rooms, with specific uses (classrooms, offices, kitchens, dining halls …). They are occupied mainly by large numbers of pupils or by a few employees.

Various uses and occupancies mean various needs and specific types of pollution which must be dealt with by the ventilation systems in order to maintain a healthy environment.

Classrooms can accommodate up to 30 pupils and a teacher at the same time, with an average renewal every hour or every two hours.

It is certainly the most sensitive and the most difficult room to handle, as it must:

- Be comfortable as most occupants are not moving;
- Offer a good healthy Indoor Air Quality to help occupants concentrate;
- Be quiet (noise is a main issue).

A classroom is also a place with a high occupancy ratio.

Beside classrooms, other types of rooms are available to the pupils such as libraries, which have a very variable occupancy, medical premises (doctor's office, sick room, changing rooms), which are not often used, or sanitary accommodations, used mainly during breaks.

The administrative part includes offices (occupied during the day), archive rooms (almost never occupied), teachers rooms (with variable occupations) and sanitary accommodations. The activity in all these rooms is similar to that of offices.

Such variable occupancies and uses call for an intelligent and efficient ventilation system. Demand Controlled Ventilation is a solution particularly adapted to this situation.

Pollutants
and Indoor Air Quality Indicators

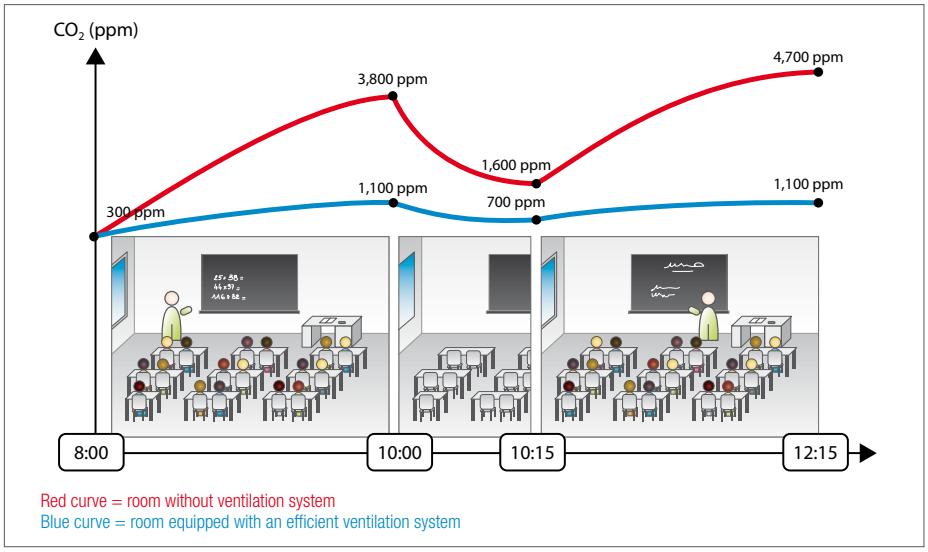
Ventilation and CO_2 concentration

CO_2 concentration in the air inside a room such as a classroom is considered as a good indicator of the indoor pollution due to occupants. A maximum indoor concentration of 1,500 ppm of CO_2 is commonly agreed to calculate required air changes per hours[1].

Without an efficient ventilation system, CO_2 concentration in classrooms can reach high values, in particular in schools with no mechanical ventilation (concentrations up to 7,000 ppm have been measured after three hours of class in non ventilated rooms).

Other studies show that high levels of CO_2 (5,000, 10,000 ppm or more) can cause headaches, difficulties to breathe, nausea. Consequences on the health and the work of pupils and teachers can't be neglected.

Variation of CO_2 concentration according to occupancy in a classroom with or without ventilation system (example based on measurements)[2]



On the diagram on the right, one can see that with no ventilation system, CO_2 concentration greatly varies and reaches high levels after occupancy periods. Purge ventilation by opening windows between classes is not enough to bring it down to acceptable levels. With an efficient ventilation system, CO_2 concentration is maintained at a level acceptable and comfortable for pupils and teachers.

Note: On the diagram, the reduction of CO_2 concentration between classes in case there is no ventilation system is due to the opening of windows. Without this, CO_2 concentration would reach 6,200 ppm.

Ventilation and Relative Humidity

In a classroom with 20 to 30 children present at the same time, generation of water in the form of vapour can reach 1kg/h (depending on time of year). An indoor relative humidity between 35% and 65% is considered comfortable for the occupants and adequate to maintain the fabric of the buildings. Below 30%, the air becomes too dry; above 70%, the air becomes too humid.

For this reason, systems that modulae the airflows based on relative humidity such as those manufactured by Aereco (humidity-sensitive ventilation systems) prove to be particularly efficient to maintain relative humidity levels within the comfort zone.

Odours and VOC

Other pollutants, more or less harmful, can also be found at high concentration if the ventilation system is not appropriate. Odours can quickly be a source of discomfort and damage the focus of the pupils. VOC emitted by materials, paints, etc. can be a significant risk to the health of children and personnel if they are not managed properly.

1. CO_2 concentration outside can greatly vary depending on the location.
2. Source: Efficient Ventilation for Schools - Design Guide (CETIAT, France, 2001)

Criteria and requirements
for an efficient ventilation of school properties

The main criteria to take into account when designing a school are linked to the need of the occupants (IAQ), to the necessity to maintain good conditions inside (comfort zone, acoustic comfort), as well as to economic constraints (investment cost, maintenance cost).
Requirements for IAQ are defined in the UK by the Building Bulletin 101. They are valid for schools as well as for children's centres and other early-years settings, including nurseries, playgroups, etc.

Indoor Air Quality

Regulations in the UK[2] call for minimum levels of airflow/occupants between 3 to 8 l/s depending on room type. There are also requirements in terms of maximum CO_2 average concentration (1,500 ppm over one day) and acceptable peaks (< 5,000 ppm). In naturally ventilated schools, purge ventilation by opening windows is necessary to maintain adequate CO_2 levels. This often leads to having the choice between draughts and high heat losses on one side and good IAQ on the other. Having an automatic control system for ventilation is the solution.

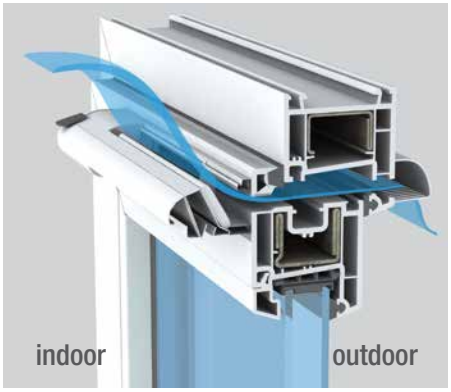
Comfort Zone

Temperature, speed and relative humidity are the main characteristics of the air which influence comfort in a room.

Temperature and Air Flows

In a school, bringing air inside can be difficult in classrooms, dining halls and kitchens, because of the high airflows required and because of the low air temperatures outside in winter, when it is not pre-heated. The speed of the air when it is introduced in a room, together with its initial temperature, can create an air gush which impacts on comfort and IAQ.

In winter, when the air supplied to a classroom is taken directly from the outside (extract only ventilation), it must be supplied gradually and not be directed toward occupants. Inlets with air flows toward the ceiling optimise air warming and improve thermal comfort. When the system includes supply and extract units, the air supply must be at a relatively low speed and must spread before reaching occupants (especially in the absence of pre-heating device or heat recovery).



Humidity sensitive air inlets from Aereco optimise the diffusion of fresh air by directing it toward the ceiling, which helps warming it up.
Nevertheless, it is important to underline that ventilation systems (whether extract only or balanced) deal with rather low airflows compared to those of air conditioning systems.

Humidity

An indoor relative humidity between 35% and 65% is considered comfortable for the occupants and adequate to maintain the fabric of the buildings. Below 30%, the air becomes too dry; above 70%, the air becomes too humid.

Acoustic Comfort

Acoustic issues are essential in school properties, in particular in classrooms. They must be taken into account in the buildings' layout as well as in the fixtures and fittings at design stage. It includes insulation in general (between rooms, towards outside) as well as within rooms (materials, residual noise). Now, ventilation systems can influence the acoustic comfort because they generate and can also transfer noise.

In the UK, reference is made to performance standards in Table 1.1 of Building Bulletin 93, with definitive guidance in BB101, paragraph 1.6.

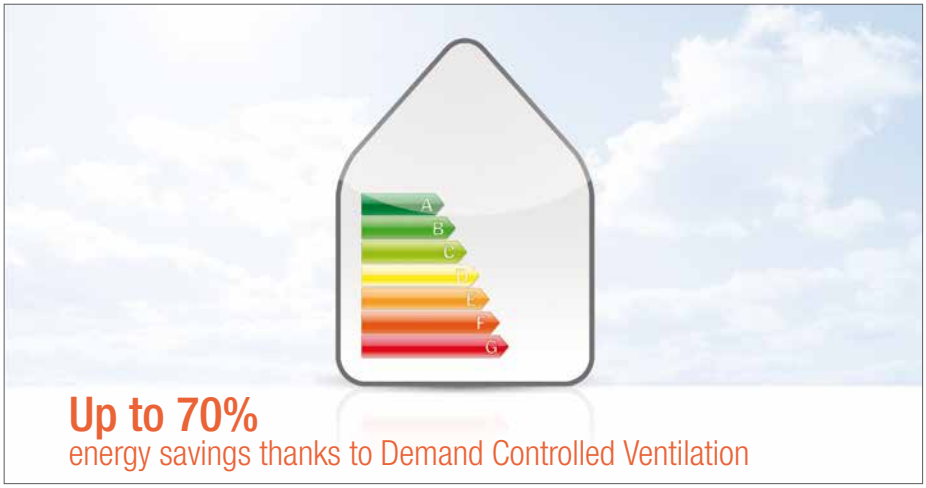
Fire Considerations

The ventilation system installed must also take fire regulations into account.

2. References: www.teachernet.gov.uk / Building Bulletin 101 version 1.4 dated 5th July 2006 / Ventilation and Indoor Air Quality in Schools –Guidance Report 202825 - Building Research Technical Report 20/2005 – March 2006 / Exeter University research on the effect of carbon dioxide on pupil performance / www.teachernet.gov.uk/acoustics.

Combining Energy Efficiency
and Indoor Air Quality

Just because the main purpose of a ventilation system is to improve the Indoor Air Quality, it should not sacrifice the energy performance of the building.



Up to 70%
energy savings thanks to Demand Controlled Ventilation

It is clear that opening windows from time to time does not guarantee a good air quality. But the impact on heat losses is particularly bad during cold or mild seasons, because the cold fresh air brought in must be heated up, at a high energy cost.

A constant airflow ventilation system improves the situation, because stale air will be evacuated faster. However, constant airflows do not deal with **pollution peaks due to temporary over-crowded rooms; they also create high heat losses when the classrooms are empty or little used**, even if the system is on a timer based on school working hours. These periods can represent up to 50% in a day (breaks between classes, classes cancelled, lunch, etc.); **a huge quantity of energy can therefore be saved by reducing the airflows to a minimum during these periods.**

Energy can also be saved in another field: the power consumption of the fans. By modulating the airflows according to the needs, the average airflow can be greatly reduced, which also reduces the energy consumption of fans if they work on constant pressure, as all Aereco fans do.

By modulating the airflows according to the needs of the occupants of classrooms, **the Aereco ventilation systems optimise both energy consumption and Indoor Air Quality. Heat losses can be reduced up to 70%[3].**

3. Savings with the "MDA" modulating ventilation system based on activity detection, as certified by CSTB in the Avis Technique n°14/07-1158 (France). Depends on layout and components used.

Aereco: efficient solutions

adapted to specific schools requirements

The key to defining the proper ventilation in a school or a crèche is to adapt the various terminals to the relevant IAQ indicator in each room. Based on the activity in a given room, the choice of a terminal monitored by humidity, presence, activity level, CO_2 or VOC concentration or a mix of the above will optimise energy savings while maintaining a high IAQ level.

Solutions exist

In order to choose the most adapted ventilation strategy, several parameters must be looked at: IAQ indicators, comfort of children and personnel, energy consumption of the system, ventilation heat loss, installation cost, capital cost, lifetime cost, maintenance cost, to name the most common. The best solution is not necessarily the most expensive, in particular in the case of retrofitting.

Extract only ventilation systems

Fresh air is introduced in the classrooms and "dry rooms" thanks to humidity sensitive window or wall air inlets. They automatically and gradually open or close depending on relative humidity inside each room.

In parallel, extract units located in classrooms and "wet rooms" (toilets, kitchens…) evacuate stale air. They also automatically and gradually open or close depending on the most relevant indicator in each room: relative humidity, presence, CO_2 level, VOC level, or a mix of the above.

To complete the system, all extract units are connected to one or several central fans. They are monitored by the extract units and maintain a constant pressure in the network while extracting only the amount of air necessary to ensure a good IAQ.

Supply and Extract ventilation systems

In the case where fresh air does not come through the external envelope, it is supplied through a network of ducts connected to one or several central fans. "Slave" modules are adapting the supply of air at the level defined by the "master" modules on the extract side, so as to keep the system balanced.

Additionally, part of the heat extracted by the system can be recovered to help warm the fresh air coming in.

EHA² - Humidity sensitive acoustic air inlet

BXC - Extract grille with integrated CO_2 or VOC sensor

Design Service

We are available to help you design the most efficient and cost effective ventilation system in your particular case. Feel free to contact us at your convenience.

BXC - Humidity sensitive extract grille with presence detection

VAM - Central fan

Typical examples

Extract only ventilation / Type of room	Classroom	Library	Documentation centre	Sick room	Changing room	Toilets	Playtime room	Teachers room	Offices
Humidity sensitive acoustic wall or window air inlets	+++	+++	++	++	++	-	+++	+++	+++
Humidity sensitive extract grilles	++	++	+++	++	+++	+	++	+	-
Extract grilles with presence detection	++	++	++	++	++	+++	++	+++	+++
Humidity sensitive extract grilles with presence detection	+++	+++	+++	+++	+++	+++	+++	+++	+++
CO_2 activated extract grilles	+++	+++	+++	+++	+	++	+++	+++	++
VOC activated extract grilles	++	+++	+++	+++	++	+++	++	++	+++
Extract grilles connected to a module monitored by presence detection	+++	++	++	++	+++	+++	++	+++	+++
Extract grilles connected to a module monitored by activity detection	++	+	+	++	++	+	+++	+++	++
Extract grilles connected to a module monitored by CO_2	+++	+++	+++	+++	+	++	+++	+++	++

Supply and extract only ventilation / Type of room	Classroom	Library	Documentation centre	Sick room	Changing room	Toilets	Playtime room	Teachers room	Offices
Grilles connected to a module monitored by presence detection	+++	++	++	++	+++	+++	++	+++	+++
Grilles connected to a module monitored by activity detection	++	+	+	++	++	+	+++	+++	++
Grilles connected to a module monitored by CO_2	+++	+++	+++	+++	+	++	+++	+++	++

This tables are indicative only. It is necessary to have all elements (drawings, site visits) to adapt a solution to the specific requirements of every case. We are available to help you design the most efficient and cost effective system.

Presence sensor for MDA

MDA Module

VCZ – collective exhaust fan

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