Controlled comfort

Inadequate controls - by today's standards - are estimated to cost industry and commerce £500 million a year in wasted energy. Terry Walters, chairman of the Building Controls Group of the Energy Systems Trade Association, looks at the opportunities in ventilation and air conditioning.

Ventilation systems are required only to provide ventilation for human occupants. Starting and stopping the ventilation system from a time switch set to occupancy times is usually sufficient. If the ventilation system is used to provide heating as well, an optimiser should be used. Under these situations the plant is started with its mixing dampers in the recirculation position. until occupancy, when normal control resumes. Ventilation systems are normally designed to ensure good air quality for the maximum number of people ever expected in the area. They do this by allowing a certain quantity of outdoor air per person. This is called the minimum fresh air requirement.

The control systems will position the mixing dampers to ensure that a minimum amount of outdoor air is supplied all the time the system is operating. This is a very arbitrary method, as will be seen if we consider the various quantities of outdoor air required for different situations (Table 1). Note the difference between air change rates for smokers and non-smokers and between the UK and ASHRAE figures. Clearly air quality is a subjective judgement.

Typical fresh-air requirements per person for different situations (in m³/h)

	Smokers (UK/ASHRAE)	Non-smokers (UK/ASHRAE)
Theatre/concert hall	54/60	18/12
Conference room	60/60	12/12
Classroom	50/42.5	17/8.5
Restaurant	45/60	15/12

When supplying ventilation to rooms with sharply varying occupancy levels there is always a basic conflict between the desire to maximise the outdoor air for occupant comfort and the requirement to minimise the energy consumption. As a rule, too much outdoor air is supplied because the minimum outdoor air rate is based upon maximum occupancy. Consequently, when the room is not fully occupied, too much energy is used, distributed and emitted.

It has been shown that heating and humidifying the outdoor air alone consumes more than 50% of the annual cost of an air-conditioning system.

For a number of years sensors have been available that measure the air quality of the space. When the area is unoccupied or the air is not contaminated, the air-quality sensor allows full recirculation of the room air, thereby saving costs. Installing air-quality control removes the wasteful practice of manually setting the damper minimum-outdoor-air position, with the result that the space is more comfortable and consumes less energy.

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Air-quality sensors address this problem. When an area is unoccupied or the air is not contaminated, an air-quality sensor allows full recirculation of the room air - thereby saving costs.

> ***"All employers expect the time we spend at work to be highly productive, and some would say this productivity should take precedence over saving energy"***

Some years ago, a well known high-street store group evaluated air quality. It found that in some stores no outdoor air was required at all. Customers brought in sufficient outdoor air as they came into the store.

Poor air quality can be caused by a number of factors.

- Lack of oxygen.
- Excess of carbon dioxide.
- Gases produced by building or furnishing materials.
- Body odours from people.
- Tobacco smoke.
- Cooking smells.

Two types of air quality sensor are available — for carbon dioxide and mixed gases.

Measuring the amount of carbon dioxide in the air is most suitable in situations when there is a high density of people in the space. In these conditions the amount of carbon dioxide given off by the people will be the most significant factor in the quality of the air.

Mixed-gas sensors can detect a whole range of gases and impurities in the air, and are most suitable when the density of people is low. In these situations, gases given off from building, furnishing materials or tobacco smoke will generally be the contaminating factor.

Both types of air-quality sensor operate in conjunction with a controller that adjusts the amount of outdoor air to ensure the air quality of the space is maintained at the lowest energy cost.

Occupancy sensors

If energy consumption is to be minimised, short operating times are desirable. The aim should be to control the on and off times so that thermal-comfort conditions are provided only during occupancy. A combination of optimisers, 7-day and yearly time switches can be set to achieve this.

However, this approach assumes that the occupancy periods are known in advance, which is rarely the case, especially with companies working flexible hours. The period within which the flexible hours can take place often exceeds 12 hours, while the actual time worked is no longer than 8 to 9 hours. In many cases the occupancy time is considerably smaller, as for example, in meeting and conference rooms, canteens, sales offices, archives, training and lecture theatres, laboratories, display and demonstration rooms. Even normal offices are unoccupied some of the time. These interruptions to normal occupancy are generally short-lived, owing to meetings, lunch breaks etc, but in certain circumstances (illness, holidays) may last for days or weeks.

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The fact that, in practice, room occupancy cannot be accurately determined in advance means that rooms are supplied with energy during the entire potential occupancy period, whether it is required or not. Clearly, control devices that monitor occupancy have considerable energy-saving potential.

Energy may be saved by minimising the ventilation heat losses by switching off either all or part of the plant or by changing over to 100% recirculated air. In addition minimising the distribution losses by switching off the fans and pumps or by changing over to a more economical operation (fan-speed reduction, 2-speed fans). Fabric losses can be minimised by lowering the temperature during non-occupancy periods.

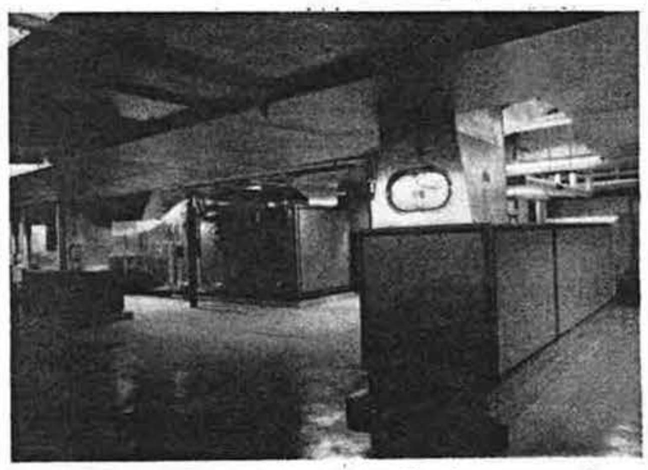
Air conditioning

Air conditioning can benefit from the use of occupancy and air-quality control. In addition, savings can be made by using the free energy in the extract and outdoor air of air-conditioning systems. If this energy is used to optimum effect, the cost of providing energy for heating/cooling or humidifying/de-humidifying can be drastically reduced. Optimum use is achieved when energy is taken from the extract air and transferred to the outdoor air, eliminating the need for energy to preheat the outdoor air. Various means are available to carry out this process, such as regenerative recovery using heat wheels or rotary heat exchangers, recuperative recovery using run-around coils, and direct return air mixing.

> ***"Getting the best out of control systems involves the careful selection and application of the control devices"***

The first two methods require expensive equipment. The latter method can be achieved by adding some simple controls. Some existing systems may already be using the dampers to mix air to assist in the temperature control of the system. Generally these systems use outdoor air as the first stage of cooling the space, followed by mechanical cooling, a process called free cooling. This system begins to break down when the outdoor air is at a higher temperature than the extract air. Under these conditions it is cheaper to cool the extract air mechanically, supplying outdoor air only to maintain air quality. By comparing outdoor air temperature and return air temperature, it is possible to ensure that outdoor air is only used for free cooling when it is at a lower temperature.

When plant is providing both temperature and



Installations with air-handling units offer the prospect of taking energy from the extract air and transferring it to the indoor air, eliminating the need for energy to preheat the outdoor air. Simple controls make possible the use of direct mixing of return air, which is much cheaper than thermal wheels or run-around coils.

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humidity control, the problem of selecting the correct air supply source becomes more difficult, but controls can provide the answer. Temperature and humidity sensors are installed in the extract and outdoor air inlet. Signals are supplied to a controller that can calculate the total heat in both ducts. In addition, signals from the temperature and humidity control systems indicate what form of energy is required by the space.

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Armed with this information the controls position the dampers to assist the most expensive form of energy that is required by the system. This type of control is called enthalpy comparison. Installing the same controller, but without humidity sensors, will produce temperature comparison, which is suitable for systems controlling temperature only.

Modern working practices, combined with heat-producing equipment such as computers and copiers, contribute to produce great variations in room load. Control via simple thermostats or room controllers together with the practice of providing heating and cooling at every possible outlet is no longer an affordable solution.

Theatres and concert halls where smoking is permitted require three times as much air as those where there is no smoking. And, of course, much less air is required during rehearsals. Air-quality sensors provide a means of responding to changing requirements.

"Air conditioning can benefit from the use of occupancy and air-quality control"

Controls manufacturers have sought to provide control systems that take more account of the individual or building demand, and systems are now generally available that do just that. The most efficient method of control is at the point where the energy used is the energy that is in the room.

Such room controllers can provide the following facilities.

- Normal, 'occupied' control, with energy-saving deadbands between the heating and cooling setpoints.
- Stand-by or unoccupied control, where the deadbands between heating and cooling are widened.
- Night setback, incorporating anti-condensation or frost protection.
- Energy hold-off, to switch off the heating and cooling, if, for example, windows are left open.

Some systems offer communications between controllers and the primary plant, allowing:

- complex area/zone time switching arrangements;
- frost and building fabric protection;
- demand-based primary energy production;
- the ability to read room temperatures and make adjustments from any point on the communications bus.

Conclusion

In conclusion, all the controls mentioned above are stand-alone systems. That is to say they do not rely on building-management systems for their operation. They could be electronic, pneumatic or direct digital control. They are all capable of providing energy-saving control routines in their own right and can be inexpensive to install.

Improved control over all aspects of indoor air quality reduces complaints from the occupants and improves their productivity and general health.

In addition, good controls reduce the time taken by maintenance staff to investigate complaints, allowing them to make quick and simple adjustments.

Another advantage of improving existing control systems is that the improvements can be carried out gradually, stage-by-stage, financed out of revenue. No large capital expenditure is required.

Please do not think that to improve your control system or save energy you have to replace all existing equipment; that is not the case.

Finally, remember that control systems save energy directly. Once you have an efficient control system, you can consider installing a building-management system to help save more money by managing the building more efficiently. □

Terry Walters is marketing manager with Staefa Control System.

The role of advanced controls in ventilation systems will be highlighted in a future issue.