The Green Consultancy - Mechanical Ventilation

Ventilation types

Mechanical ventilation usually takes the form of air-handling units which incorporate fans and their motors, as well as some or all of filtration, heater and chiller batteries and provision for heat recovery. Smaller systems may utilise simple extract and/or supply fans without air treatment, and there are many installations which fall somewhere between the two.

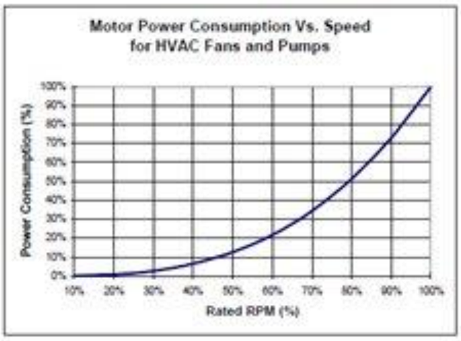
Mechanical ventilation often uses a considerable amount of energy, both in electricity for the drive-motors, and thermal energy for heating and cooling. Very few operate at anywhere near 100% of their theoretical efficiency, and the result is that there is usually considerable scope for realising savings, often with very limited capital investment.

Ventilating efficiently

Ventilation should be used in order to satisfy a single over-riding requirement: to maintain appropriate air-quality within the ventilated volume. It should therefore be sufficient to remove contaminants such as carbon dioxide (CO_2) from respiration, or humidity. However, if energy use is to be minimised, then the use of ventilation must also be reduced to the minimum level consistent with the achievement of the aim. This is important as reductions in ventilation rates result in significant reductions in both electricity and thermal demands.

The crucial electrical fact

The most important fact to grasp is that there is a cubic relationship between the speed of a fan and the power required to run it. For example, a 10% reduction in fan speed will reduce energy use by about 25%. Thus the benefits of even small reductions in fan speed are overwhelming. Big reductions, which are frequently achievable for much of the time, can result in the reduction of fan electricity consumption to relatively insignificant levels.



Correct system design

The design of mechanical systems should take into account the purpose to which the area ventilated is going to be put, and the number of people accommodated. CIBSE generally recommends a ventilation rate of 10 litres/person/second, and this figure is not unreasonable if the space has long-term occupancy. However, this requirement is frequently exceeded and ventilation often runs at a fixed speed, without any variation for the level of occupancy at any one time. The measurement of ventilation rates in numerous buildings has shown that often ventilation rates are sufficient to provide for ten-times as many people as are actually accommodated, and as occupancy can often vary (in some cases to zero), the scope for savings is obvious.

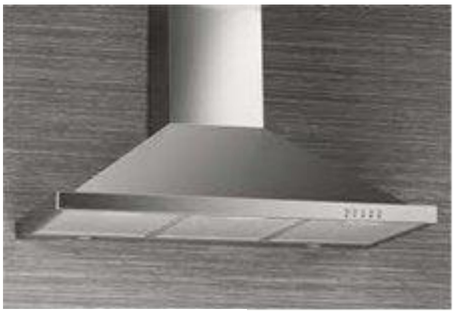
Permanent rate reduction

In extreme cases, a permanent reduction in ventilation rate is likely to be completely appropriate, and this might be achieved through the adjustment of pulley sizes or variation of blade angle on axial fans, or possibly replacement of drive-motors and or fans. The optimum solution will vary according to the application, but in many cases the speed of centrifugal fans may be reduced simply by changing the pulleys, and this may achieve a payback measured in weeks, or possibly even days in extreme cases.

Variable ventilation rate

Although a permanent reduction in ventilation rate is often an attractive proposition, the greatest savings will accrue if the ventilation rate can be varied by the BMS according to the conditions, the primary determinant being occupancy. The best way to do this will be to actually measure the air-quality, usually using a CO_2 detector, and increasing the ventilation rate as the measured level increases above about 450 ppm (the current ambient level is about 400). Most organisations aim to have the ventilation running at full speed by the time the level has increased to 1,500 ppm, but in practice very few systems using this operating method actually reach full speed. Similar practice may be applied using humidity or other determinants as appropriate.

Small extractors



Varying the ventilation rate is appropriate for larger systems, but many sites have large numbers of small fixed-speed extractors for purposes such as kitchen, toilet and bathroom ventilation. These fans may seem small and innocuous, but together they can place a substantial thermal load on a building, and unless controlled may continue to do this all night and at weekends when the building may well be completely unoccupied. For these, linking their operation to occupancy, possibly using presence detectors, and employing time schedules utilising BMS control or local timers can generate savings out of all proportion to the capital outlay.

Other benefits

Reduced ventilation rates often have other benefits as well. A secondary purpose of ventilation is to remove heat from buildings, but if the ventilation rate is very high, occupants may suffer from cold draughts if the supply temperature is too low. Reducing the ventilation rate may therefore allow lower supply-air temperatures to be employed reducing energy use still further. Assuming heat recovery of reasonable efficiency and a target air-temperature within the building of 20^oC, it may be possible to reduce the supply temperature set-point to 15^oC, and avoid the use of the heater battery in ambient temperatures above 10^oC. This is achievable for many sites and the reduction in thermal energy use will be significant.

For ventilation systems incorporating cooling, it is again important to minimise ventilation rates as the closer the ambient temperature is to the set-point the less cooling there will be. Furthermore, if the supply fan motor is located within the air-flow then 100% of the electricity used to operate it will be dissipated as heat thus increasing the cooling load. If the motor is remote from the air-flow this figure drops to 80-90%.

In general, supply air-handling units should not have set-points in excess of 15^{o}C and if this causes complaints about cold draughts then the ventilation rate may be too high or there is an issue with the design of the system.

In addition, running plant for shorter hours at lower outputs generally reduces maintenance demands as well as energy use.

Infection control

It should be noted that most “bugs” such as clostridium difficile, norovirus and legionella breed readily at temperatures in excess of 20^{o}C, and that operating AHUs at lower temperatures can be extremely beneficial from the infection control point of view. This is likely to be particularly pertinent to hospitals, nursing and residential homes and similar organisations.

Identifying the opportunities

An Investment Grade Energy Efficiency Audit will reveal the opportunities for minimising mechanical ventilation rates and supply air temperatures, with the following multiple benefits:

- reduced electricity consumption
- reduced heating consumption
- reduced carbon emissions
- reduced maintenance costs
- increased comfort for building users
- improved infection control

Such opportunities should also be flagged up by BMS Audits, BMS Health Checks, and Air Conditioning Inspections, particularly if the latter go beyond the mandatory requirements.

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