LOW ENERGY VENTILATION REFURBISHMENT OF OFFICES

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ABSTRACT

Many existing offices either overheat in the summer or use excessive amounts of energy to maintain acceptable temperatures. The reasons are increasing internal heat gains from office IT equipment, poor efficiency lighting systems, density of staff and original poor building design causing excessive solar gains. The trend is for problem offices to have AC systems replaced - at the end of the life of the existing services - or installed in previously naturally ventilated offices when refurbishment occurs.

The retrofitting of natural and low energy ventilation systems in existing UK office buildings during refurbishment can maintain comfortable indoor conditions and result in significant energy and CO2 savings compared to the common solution of just installing AC.

Where natural and low energy ventilation strategies do not eliminate the need for air conditioning altogether, they can improve the situation by one or more of the effects below:
(i) reducing the ac load (by reducing internal gains and using the thermal mass of the fabric with night cooling)
(ii) reducing the area of the office where ac is needed (spatial mixed mode)
(iii) reducing the proportion of the year when ac is needed (temporal mixed mode).

We have considered four likely levels of office refurbishment, together with the opportunities for natural and low energy ventilation measures to be introduced for each level of refurbishment.

Level 1 is a minor refurbishment and involves the introduction of opening windows, reduced window area, modern internal blinds, low energy IT option on replacement, re-painted interior and re-designed office layout to maximise access to available daylight.

Level 2 is an intermediate refurbishment, as level 1 but with mid-pane blinds for solar control, a new, more energy efficient lighting and control system, removal of false ceiling to expose thermal mass and raise ceiling height, providing the possibility of occupant controlled night cooling.

Level 3 is a major refurbishment, as level 2 but with external solar control, possible use of stair cores as ventilation stacks, BMS controlled night cooling with motorised window/vent opening.

Level 4 is a complete refurbishment, options as level 3 and with radical changes to air flow paths, for example by addition of a central atrium, or use of a double facade to drive stack ventilation.

We have used an added level of refurbishment, AC Upgrade which involves just the replacement or introduction of a typical fan coil AC system and allows comparison with the low energy ventilation approach. The new or replacement AC system is assumed to be a fan coil AC system, with a COP of 3, set point of 22*C, typical low velocity fans and 100% air re-circulation, giving 5 air changes per hour. It is assumed to operate when the building is occupied.

Simple low energy mechanical ventilation can be used in conjunction with the measures and strategies described above for each level of refurbishment where the result of their being retrofitted does not quite eliminate the need for AC. A simple low energy mechanical ventilation solution should use high efficiency fans with a minimum of ducting and only be used when and where the natural ventilation driving forces need to be supplemented. The system investigated here, in conjunction with cases where the natural ventilation refurbishment just fails to meet the summer comfort criteria, is a simple mechanical extract using best practice low energy fans, operating only in the peak summer months, in the areas of the office building where it is required.

The benefits of retrofitting natural ventilation and low energy ventilation solutions to existing office buildings during refurbishment have been assessed using the BRE design tool NITECOOL (refNitecool).

The acceptability criteria used to assess the success of the low energy ventilation refurbishment strategies in this study are:

* an internal maximum DRT for the July hot week of 28*C (this is 1*C above the maximum outside air temperature used in the simulation)
* a maximum of 15% of occupied hours over 27*C in the July hot design week (with an overall yearly maximum hours over 27*C of 2% of occupied hours).