The trend towards natural ventilation and low energy cooling systems is affecting the ways in which engineers design and operate heating systems in low energy buildings.

STEVE IRVING REPORTS

Heating low energy buildings

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Forthcoming industry workshops will prioritise research issues for further study. Those interested in taking part in the workshops should contact Denice Jaunzens at the BRE on 01923 664522 or Steve Irving on 01508 538808.

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Over the last 20 years there has been an important shift in design standards. Steady-state heat gains and losses in buildings are now more in balance, such that the heating system input needed to maintain temperature is small or even non-existent.

At the same time ventilation loss has become the dominant element. If ventilation can be well controlled, night-time heat losses and hence the pre-heat demands will be quite small. Heating system size can then be reduced, with savings in capital cost and space allocation.

The BRE is currently working with Oscar Faber Applied Research[1] to develop a cpd package for CIBSE members on the design of heating systems for low energy buildings.

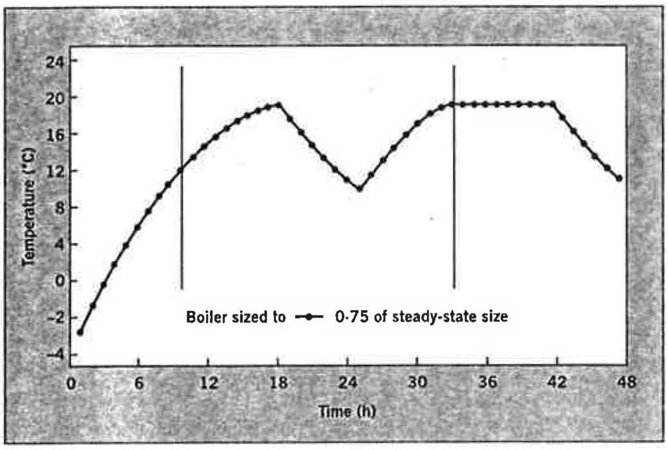

FIGURE 1: Heavyweight building response to different sizes of boiler plant.

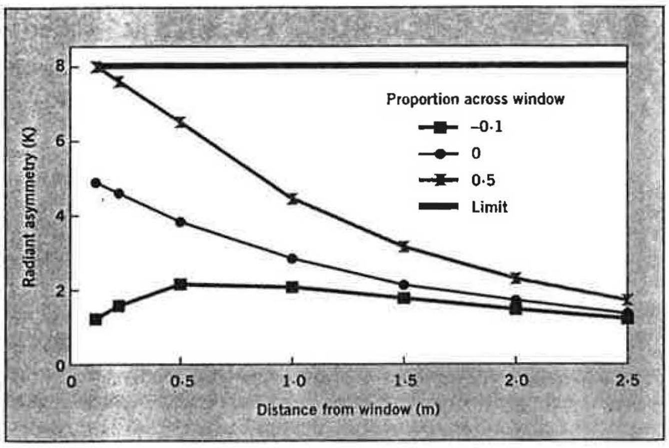

FIGURE 2: Radiant asymmetry – current insulation standards.

A lumped parameter model was set up as part of the research. The aim was to test how a building would respond to different sizes of boiler plant if the ventilation was controlled such that the heat loss was only incurred when ventilation was required (ie when the internal gains were also operational).

Figure 1 shows the results of this analysis for a heavyweight building. The building starts off at a temperature equivalent to the constant outside temperature of -3°C (the vertical bars denoting the beginnings of the occupied period).

Even for a heavy building, and with a heating system smaller than the conventional steady-state heat loss, the temperature is under control by the second day. This suggests that there may be benefits to be gained from reviewing how heating systems are sized in low energy buildings.

However, there are important caveats. First, ventilation losses must be under control. Second, the analysis assumed occupancy and ventilation rates rose instantaneously from zero to 100%. In reality, a building is occupied progressively, with internal gains ramping up accordingly. If the internal gains are to offset the losses, some form of demand-controlled ventilation will be needed.

There are potential benefits if these challenges can be overcome – there will be reduced capital and operating costs as oversized and inefficient plant will be avoided.

Another consequrence of the reduced losses is the potential for ceiling heating systems. Well-insulated and airtight buildings have a design heat loss of 20-35 W/m^2 of floor area (depending on the number of external walls and ceiling/roofs). This is within the capacity of heated ceilings. To satisfy comfort criteria, these are limited to outputs of around 40 W/m^2.

Such systems have an inherent self control. Surface-to-room temperature differences are small, so a change in room temperature will automatically modulate system output.

Passive buildings are designed around the concept of swings in internal temperature, supporting the use of a combined ceiling system for both heating and cooling.

Heating to 20°C and cooling to 26°C could be achieved without varying the circuit flow temperatures outside a range of, say, 30°C (for heating) and 18°C for cooling, especially in a very well insulated, thermally massive building. This would require a single heating/cooling circuit which could then be fed by a reversible heat pump.

The single circuit could reduce capital costs, while the low temperature lift in heating mode would also give a good coefficient of performance.

Perimeter heating has been the norm because of the need to control potential discomfort here. CIBSE *Guide A1* states that discomfort is avoided if radiant asymmetry is below 8 K.

Figure 2 details the results of an analysis based on current *Building Regulations* standards. Here, the glass U-value is taken to be 3·0 W/m^{2}K.

The lines show how the plane radiant temperature reduces with distance from the window for three different vertical sections – through the mid-point of the glazing, at the edge of the glazing and at a distance 10% of the glazing width outside the line of the glazing (external temperature is -3°C, internal design temperature is 21°C).

Here, plane radiant temperature never exceeds 8 K. Similar analysis suggests that even with full-height glazing, reducing the glazing U-value to about 2·5 W/m^{2}K would minimise cold radiation effects. This could eliminate the need for perimeter heating, and allow flexible use of valuable space.