Natural ventilation rates in modern housing

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Ventilation is one of the most important areas of energy use in buildings where ignorance is greatest and where much more needs to be done. BRE has been measuring actual ventilation rates in modern housing and developing methods of prediction

In houses, as in any other occupied buildings, it is necessary to control the level of any airborne contaminants likely to affect the health, safety or comfort of the occupants, or lead to deterioration of the fabric. This is generally achieved by supplying fresh air to dilute the contaminant or to make up any air removed with the contaminant if this is removed at source. In order to conserve energy it is important to ensure that the required supply rate is not substantially exceeded. In principle a full supply/extract system can ensure the exact requirement when and where it is needed, but such systems are very rare in British dwellings, almost all of which are naturally ventilated.

Until recently very few measurements of actual ventilation rates in housing had been made since BRS work at Abbots Langley nearly 30 years ago, when typical winter rates of two air changes per hour (ach) were found. The increasing incidence of condensation problems over the past 10 years led to the suspicion that, apart from openable windows or other similar controllable openings, natural ventilation rates had become substantially reduced. This was thought to be due to the absence of flues in modern houses, better fitting components, increased use of solid floors, and changes in the types of wall and floor coverings.

A programme of measurements was therefore instituted and is now close to completion and final analysis. In co-operation with the Building Services Research and Information Association, who made some of the measurements, data have been collected on both whole house and individual room ventilation rates in 30 houses. Apart from achieving up-to-date values for natural ventilation rates, the aim has been to provide data for comparison with theoretical approaches for predicting ventilation rates and for correlation with simple tests for determining the 'leakage' of dwellings by pressurization techniques, such as that developed by Princes Risborough Laboratory (*BRE News* 33).

Techniques and results

Ventilation rates were measured using tracer gas techniques, employing nitrous oxide and infra-red analysis. For whole house rates, internal doors were kept open and air within the house mixed with fans. Simultaneously measurements were made of wind speed and direction, and internal and external air temperatures. These were recorded by a data logging system housed in a mobile laboratory (*BRE News* 34) and subsequently analysed by computer. Typically about 150 tracer gas measurements were made over a period of four weeks in any chosen house to give a range of wind speeds and directions.

Figure 1 shows the distribution of ventilation rates at the mean wind speed for the site, measured in 16 houses. As suspected, rates average about 0.8 ach, well below the values measured in the early post-war years.

Ventilation heat loss

Because of the variation in activity and occupancy within dwellings, it is very difficult to set specific minimum requirements for ventilation, although for average conditions a minimum average whole house rate of about 50 l/s or 0.7 ach is probably reasonable. This is close to the measured average value and indicates that the opportunity for national savings by making houses tighter is limited. It is hoped that the pressurization technique mentioned earlier may provide a simple means of determining which houses might benefit from 'tightening' – by weatherstripping, for instance – and which might have insufficient ventilation, possibly resulting in conditions such as excessive condensation. To this end pressurization tests have been carried out on many of the houses in which tracer gas measurements were made, and the results are being examined to determine whether there is a satisfactory correlation.

A possible way of reducing heat loss, while still retaining a satisfactory supply of fresh air, is to install a mechanical ventilation system incorporating heat recovery. A typical system is installed in the BRE low energy heat recovery house (see page 14). Commercially available heat exchangers have been tested and show a range of efficiencies, the best being in the range 60 to 75 per cent. Work is currently under way at the National Engineering Laboratory, under contract to BRE, for the development of a simple low-cost plate heat exchanger for use in housing. In addition, a theoretical model is being developed to enable systems for dwellings to be optimized on a cost-effectiveness basis.

However, the values measured for natural ventilation rates indicate a major problem in the application of mechanical ventilation in dwellings. As the results were obtained in houses under closed conditions, it is clear that substantial infiltration could invalidate the savings from mechanical systems. For instance, a house fitted with a mechanical system supplying 1.0 ach and including a heat exchanger of 75 per cent efficiency would still incur a heat loss equivalent on average to 1.0 ach if the average infiltration were 0.75 ach. It is clear that construction techniques to reduce possible leakage paths for infiltration, such as those which have been developed in Sweden, may be necessary to ensure any reduction in energy consumption by using mechanical ventilation.

Work is continuing aimed at a better understanding of the physical mechanisms which give rise to natural ventilation, and the ways in which they interact with each other, in order to improve computer-based methods of predicting natural ventilation rates. Complementary to this are studies to determine the aerodynamic characteristics of leakage paths and the pressure distributions due to wind at the surfaces of different arrangements of dwellings.

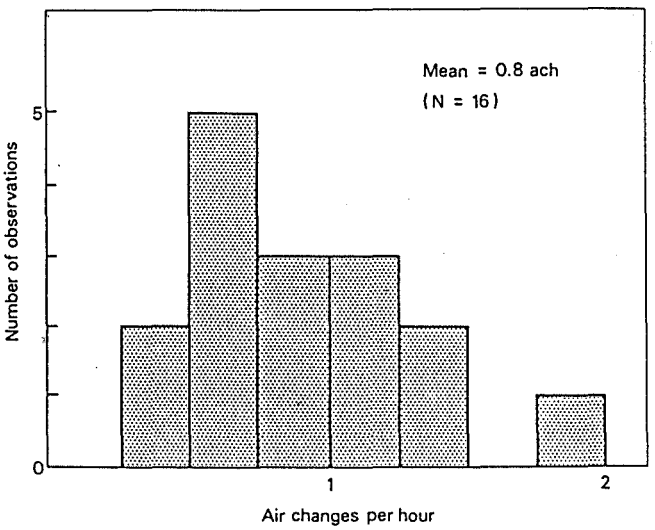

Figure 1 Measurements of natural ventilation rates in 16 new houses. Typical winter value thirty years ago was 2 ach