HUMIDITY CONTROLLED DUCTED VENTILATION

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Abstract

A significant increase has been observed in the United Kingdom in recent years in the number of instances of condensation damage in domestic properties. One of the principal causes of this increase has been the progressive reduction in air leakage of dwellings and, indeed, all other types of buildings. In many cases, draught-stripping has been implemented with no regard to the minimum ventilation rates required to avoid condensation problems. The trend at the moment is to attempt to increase purpose-provided ventilation in order that condensation may be controlled.

The cost-effective control of condensation is a large problem in the United Kingdom, especially for local authorities with large housing stocks. A possible solution to the problem is passive stack ventilation (PSV), which relies on wind and stack pressure to provide extraction. Previous work by the same authors has shown that such systems can provide sufficient levels of ventilation: however, there is a tendency for simple passive systems to give excessive extraction during periods of low occupant activity and high incident windspeeds.

This paper examines the performance of humidity-controlled mechanically-driven ducted extract systems, in terms of both effectiveness of condensation control and minimisation of energy consumption. On the basis of comparison with data obtained from previous studies of simple passive systems, the mechanical systems are shown to give a more satisfactory performance.

Introduction

The energy crisis of the early 1970's brought energy conservation in buildings sharply into public focus in the United Kingdom. Through changes in building regulations and various codes of practice, a range of energy saving measures became increasingly commonplace in both new and refurbished buildings, and particularly in dwellings. Of these measures, the reduction of air leakage was quickly seized upon as a simple and highly cost-effective means of reducing space-heating energy consumption.

However, in the relentless move towards more airtight buildings, the issue of surface condensation risk was not considered adequately: so much so that by 1986, the Building Research Establishment (1) estimated that approximately 15% of the United Kingdom housing stock was affected by surface condensation and mould growth to varying degrees.

Changes in ventilation provision are not, it must be acknowledged, the sole means of alleviating the risk of condensation: however, the ventilation rate of a dwelling can be quite readily changed, and so attempts to adjust ventilation rate have been the most prevalent means by which condensation control has been attempted. A successful ventilation strategy would satisfy all the following criteria:

(i) it would provide a level of extraction adequate to control condensation;
(ii) the rate of extraction should not be excessive, or else a penalty would be incurred in terms of an unacceptable increase in energy consumption(in cases of high over-extraction, the ventilation strategy could of course make the risk of condensation worse);
(iii) the strategy would be economically priced, easy to install, and require little maintenance;
(iv) little or no occupant training or scope for occupant adjustment would be required.

The installation of a full mechanical ventilation system would satisfy criteria (i) and (ii), but such systems are currently rather expensive within the United Kingdom, and are therefore likely to find little favour within the next five years at least. The use of simple PSV systems would most certainly satisfy criteria (i), (ii), and (iii). However, since the performance of such systems is a function of internal/external temperature difference, windspeed and wind direction, very little control can be exerted upon rates of extraction:indeed, it has been shown(2) that in houses with higher background air leakage rates, extraction of air at a rate over and above that required to control condensation can occur even at low windspeeds and internal/external temperature differences.

Excessive ventilation implies that wastage of energy is taking place. If the ventilation rate rises above a certain value for a given set of environmental conditions, then it is possible (3) that the risk of condensation can actually be increased.

Humidity-controlled ducted mechanical systems offer the possibility of fulfilling all four performance criteria. They are economically priced in comparison to full mechanical ventilation systems; the scope for occupant interference can be minimised; the use of a fan means that such a system can be set at a notional extraction rate close to that needed to control condensation;and finally, the provision of humidity-control devices can help to reduce the risk of over-extraction. The purpose of this piece of work was to monitor the performance of humidity controlled ducted mechanical systems installed in a local authority property.

Experimental

The house used for the study is shown in figure 1. It is a three-bedroomed house of traditional construction. It differs slightly from the usual practices of house layout in the United Kingdom in that the bathroom is on the ground floor instead of the first floor. The house volume is approximately 185 cubic metres, of which the kitchen and bathroom contribute 21 and 7 cubic metres respectively. Humidity controlled extraction fan units were selected on the basis of the moisture loads likely to be encountered in the bathroom and kitchen: consequently, the bathroom was fitted with an Aereco type A121 fan unit, which can operate over a range of air extraction rates between 5 and 30 cubic metres per hour, whilst the kitchen was fitted with a type A131 fan unit, which can operate over a range of 15 to 50 cubic metres per hour. A central extract fan, mounted in the roofspace and connected via 25 mm internal diameter flexible ductwork to the kitchen and bathroom extract units, exhausts air to outside via a ridge terminal. All ductwork in the roofspace was insulated in order to avoid the risk of condensation.

During the monitoring period, the following parameters were recorded using Grant Squirrel data loggers:

(i) air temperatures in kitchen and bathroom;
(ii) relative humidities in kitchen and bathroom;
(iii) external air temperature and relative humidity;
(iv) air velocities in both extract ducts.
(v) wind speed and direction.(Windspeeds encountered during the monitoring period did not exceed 5m/s.)

Results and discussion

Figure 2 shows variations in duct air velocity, internal temperature and internal relative humidity for the bathroom and kitchen respectively. It can be seen that

for the majority of the monitoring period, internal relative humidities are kept well below 70%, which is generally accepted as the upper limit beyond which condensation problems would be expected. However, it will be noted that at certain times, peaks of relative humidity occur which are well in access of the 70% level. It is questionable whether such peaks constitute a problem which justifies further design modification: if, however, such measures are deemed to be worthwhile, then the humidity controlled fan units could quite easily be exchanged for units which have a manually-operated extraction boost facility built in. The extraction boost is activated by the occupants when the need arises, and is set to cut out after 20 minutes so that there is no danger of it being left on inadvertently.

Comparison of the range of extraction rates attributable to the humidity-controlled systems with those obtained by the use of PSV systems in house of comparable air leakage (2) shows that, in addition to providing satisfactory relative humidity control for the majority of the monitored period, the humidity-controlled systems do not exhibit as wide a range of extraction rates as the simple PSV systems, thus implying that the risk of over-extraction has been significantly reduced.

Whilst the humidity-controlled systems undoubtedly give a significantly better performance than PSV systems, the latter enjoy a marked advantage in terms of price, being approximately half the price of a comparable humidity-controlled system. The choice of installation will, therefore, not necessarily be based on system performance alone, but will also have include a careful assessment of cost effectiveness.

Conclusions

Humidity-controlled mechanical ducted systems have been shown to be an efficient means of condensation control: in particular, the over-ventilation problems associated with the use of PSV systems are overcome. In circumstances where it is deemed necessary to keep internal relative humidities below 70%, a modified fan unit with an extraction boost facility could be substituted for the standard fan unit.

References

1. J P Cornish, C H Sanders, J Garratt: Building Research and Practice, Vol 13 No 3 May/June 1986 pp148-153.
2. R E Edwards, C Irwin: Proceedings of the 9th AIVC Conference, Belgium, 1988.
3. British Standards Institution: BS 5250, 1989.

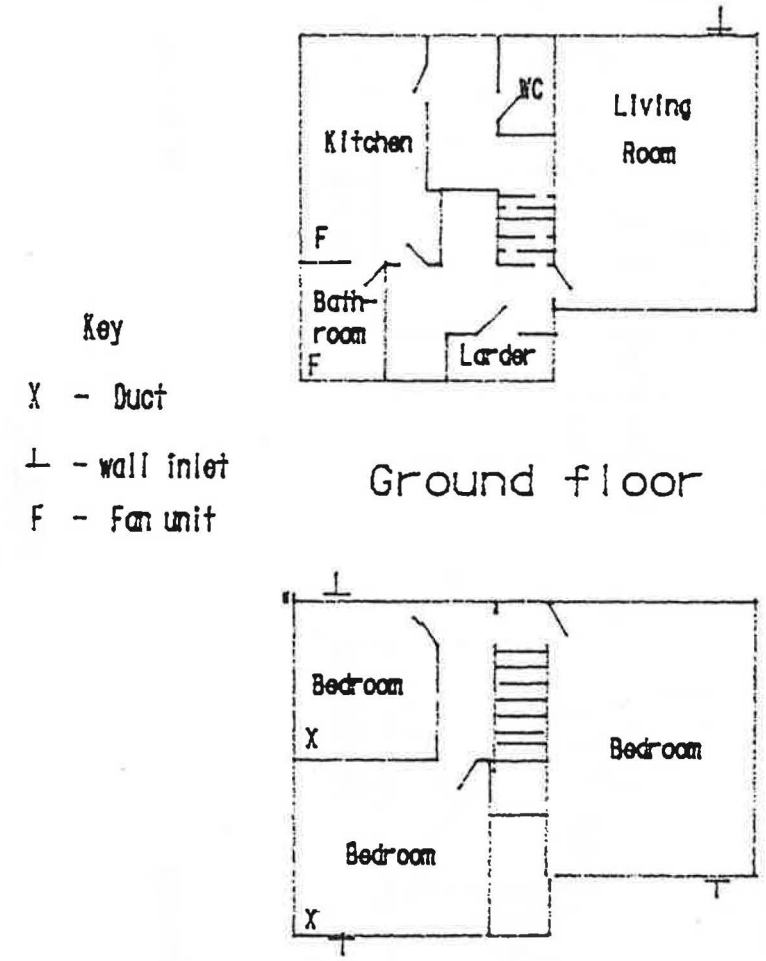
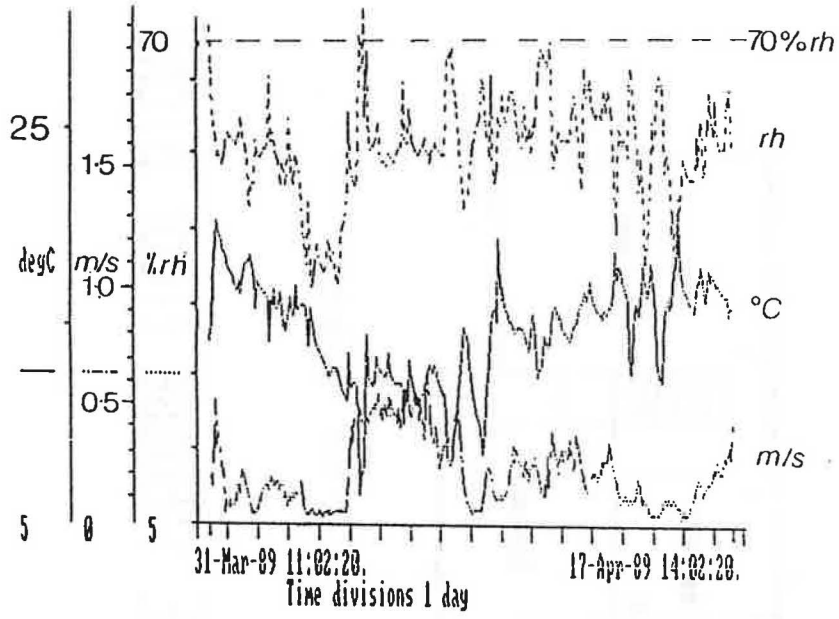
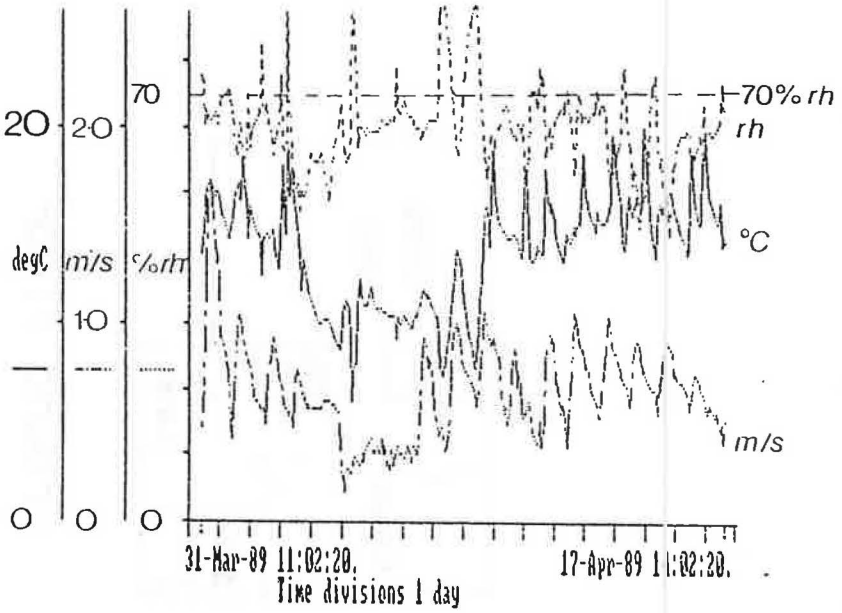


FIGURE 1:House floor plans



Bathroom



Kitchen

FIGURE 2