Positive input ventilation

Positive input ventilation systems for dealing with dampness in dwellings have been available for many years, but do they really reduce condensation? A DETR-funded research project has provided some answers.

BY ROGER STEPHEN AND JOHN BRADLEY

Positive input ventilation describes systems in which filtered fresh air is supplied to a dwelling from the roof space by means of a small fan. The air is delivered from the fan to the stairway or central hallway via a short length of flexible duct and a ceiling diffuser.

As the system takes air from the roof space, which is generally 2-3°C warmer than the outside air, input ventilation should, in principle, use less heating energy than conventional extract systems. Innovative units are now available with high efficiency fan motors, which have the potential for worthwhile savings in energy cost and CO_2 compared with other means of ventilation.

Input ventilation systems are now sold by several companies in the UK. Most units go into local authority or Housing Association owned properties, but owner-occupied and new housing also offer scope for their use.

The performance checks

While there is considerable anecdotal evidence to support the performance of input ventilation systems, their true energy and environmental impact is not well understood. To remedy this, BRE and Home Ventilation have completed a project under DETR's Partners in Innovation scheme to investigate positive input ventilation in dwellings.

The performance of positive input ventilation systems was investigated under controlled conditions by testing in an unoccupied three-bedroom house on the BRE Garston site. This involved monitoring of temperatures, humidities, energy use and weather over several periods. Tracer gas studies were also done to indicate indoor air movements and ventilation rates.

Steam and atomiser type humidifiers operated by time switches, were used to simulate a daily cycle of water vapour production by a family. A total of about seven litres of water was released throughout the house each day.

The house was fully furnished and heated by on-peak electricity to simplify measurement of energy use. Tests were made with internal doors open and closed over two to three week periods with the input fan off and then on. The air supply rate was a nominal 40 litres/s, representing a whole house air change rate of 0·7 air changes per hour (ac/h).

The field studies

Positive input systems were installed in 16 occupied dwellings in Merthyr Tydfil and Aldershot. The two-storey houses selected were understood to have existing condensation dampness problems. While this was true of the 1960s Merthyr Tydfil houses, the 1990s Aldershot houses were later found to have few problems.

Temperature and humidity levels were monitored in the roof space, kitchen, living-room and bedrooms over several months. Some weather data was measured on-site for the analysis and daily weather details from nearby weather stations was bought-in.

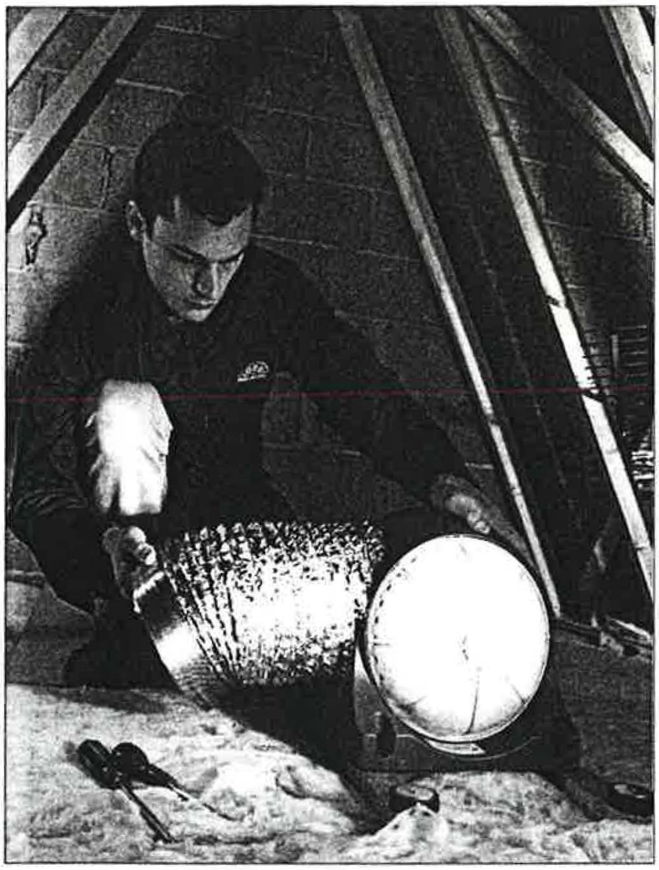

FIGURE 1: A typical installation of a positive ventilation unit, in this case a Home Ventilation Drimaster 5 unit being installed in a roof space.

For alternate periods of three to four weeks the input ventilation units were intended to be switched on and off while monitoring continued. However, because of pressure from householders to keep the input fans running, along with some difficulties over access, this schedule was disrupted in many of the houses.

The occupiers were asked about ventilation and condensation conditions in their houses before and after the monitoring.

Test house results

Input ventilation was found to be effective in reducing relative humidity levels by around 7-10% rh in the test house, even when internal doors were closed. However, although internal and external temperatures were similar for comparable monitoring periods, relative humidity is somewhat affected by temperature differences. The indoor partial water vapour pressure, minus that occurring at the same time outside, was examined to mitigate the effect of temperature differences.

When excess vapour pressures were examined, input ventilation was found to be similarly effective in all rooms with internal doors open, as shown in Table 1, over. However, with internal doors closed, it was more effective upstairs than downstairs and had more variability between rooms (for example the kitchen and living-room), as shown in table 2.

TABLE 1: EFFECT OF INPUT VENTILATION UNIT ON EXCESS VAPOUR PRESSURE (kPa) WITH INTERNAL DOORS OPEN

ROOM	FAN ON	FAN OFF	DIFFERENCE
Kitchen	0·407	0·525	-0·118
Living-room	0·400	0·527	-0·126
Bathroom	0·454	0·657	-0·204
Bedroom one	0·348	0·559	-0·212
Bedroom two	0·359	0·597	-0·238
Bedroom three	0·392	0·591	-0·199
Hall	0·381	0·535	-0·154
Landing	0·325	0·549	-0·224
House average	0·383	0·568	-0·184

NB: Excess vapour pressure is indoor vapour pressure minus outdoor vapour pressure. Difference values are for fan on minus fan off: ie a negative value indicates a fall in excess vapour pressure when the fan is on.

TABLE 2: EFFECT OF INPUT VENTILATION UNIT ON EXCESS VAPOUR PRESSURE (kPa) WITH INTERNAL DOORS CLOSED

ROOM	FAN ON	FAN OFF	DIFFERENCE
Kitchen	0·457	0·622	-0·165
Living-room	0·623	0·612	+0·011
Bathroom	0·622	1·067	-0·445
Bedroom one	0·429	0·590	-0·161
Bedroom two	0·444	0·751	-0·307
Bedroom three	0·688	0·844	-0·156
Hall	0·244	0·433	-0·189
Landing	0·235	0·503	-0·268
House average	0·468	0·678	-0·210

NB: Excess vapour pressure is indoor vapour pressure minus outdoor vapour pressure. Difference values are for fan on minus fan off: ie a negative value indicates a fall in excess vapour pressure when the fan is on.

The roof space of the test house was consistently more humid than outside, average excess vapour pressure being between 0·1-0·2 kPa. Tracer gas measurements confirmed that much of this was airborne moisture from the rooms below. The actual ventilation rate provided by the input ventilation was about 50% of that which the fan air flow rate alone would suggest. This emphasises the importance of eliminating, as far as practicable, any air leakage gaps around pipes, cables and loft hatches in the upstairs ceiling when installing input ventilation of this type.

The BRE test house was relatively airtight with an air leakage rate of 4·9 ac/h @ 50 Pa compared with a UK average of 13·1 ac/h @ 50 Pa[1]

In spite of this, the pressurising effect of input ventilation was only about 2 Pa, and that was difficult to measure because it varied considerably, even on the calm and mild day of the study. In most UK dwellings, new or existing, the pressurising effect would be considerably less.

Field studies

In the monitored houses, input ventilation was not consistently effective in reducing relative humidity, the extremes for house average values being a reduction of 5·5% rh to an increase of 1·4% rh. Even in the same house there could be a reduction in one room and an increase in another.

Input ventilation was found to be effective in the most humid houses, but did relatively little in the dryer houses. Even where it was effective, there were often inconsistencies in excess vapour pressure between rooms in the same house, or when the ventilation system was on or off.

While the measured humidity performance of input ventilation was somewhat disappointing, the occupants were more enthusiastic about the effectiveness of input ventilation than the results would suggest.

Those who previously had the highest humidity in their houses were the most impressed, citing a general improvement in indoor conditions, lack of streaming condensation on windows, and condensation on walls. Several householders were very reluctant to allow the input ventilation fan to be turned off during the monitoring exercise. Some occupants also claimed relief from severe respiratory illness but these claims could not be substantiated under this project.

Energy consumption

Energy performance was only measured in the BRE test house, and it is clear that installing a low energy positive input ventilation system will not directly save any energy. However, it may give an energy saving compared with a conventional extract system providing the same level of ventilation air exchange.

Where the input fan is supplying truly fresh air (ie where there is an airtight ceiling) the relative saving is estimated to be a maximum of about 150 W in an average modern family house. This is equivalent to about 550 kWh over a heating season. Actual relative savings will be less due to recirculation of room air via the roof space.

Input fan control

For the monitoring periods with the input ventilation fan switched off, the ceiling diffuser was always sealed with masking tape. This followed observations in the test house and one of the Merthyr houses before monitoring began in which the tape was omitted and the input fan switched off in cold weather.

Moist air from the house rose by stack effect through the input ventilation unit and water condensing on the cold flexible duct then ran down to drip from the ceiling diffuser.

The implication of this is that while the fan may be switched off to avoid overheating when roof space temperature is excessive (current units typically do this at about 25 C), it should not be switched off to avoid cold draughts when the roof space is cold.

References

Stephen R K, 'Airtightness in UK dwellings: BRE's test results and their significance', BRE Report *BR359*, CRC, 1998.

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