44

Achieving a Balance: Airtightness and ventilation standards; Air Infiltration Centre

46

House Full of Horrors: Indoor air pollution; progress in eradicating hazards

48

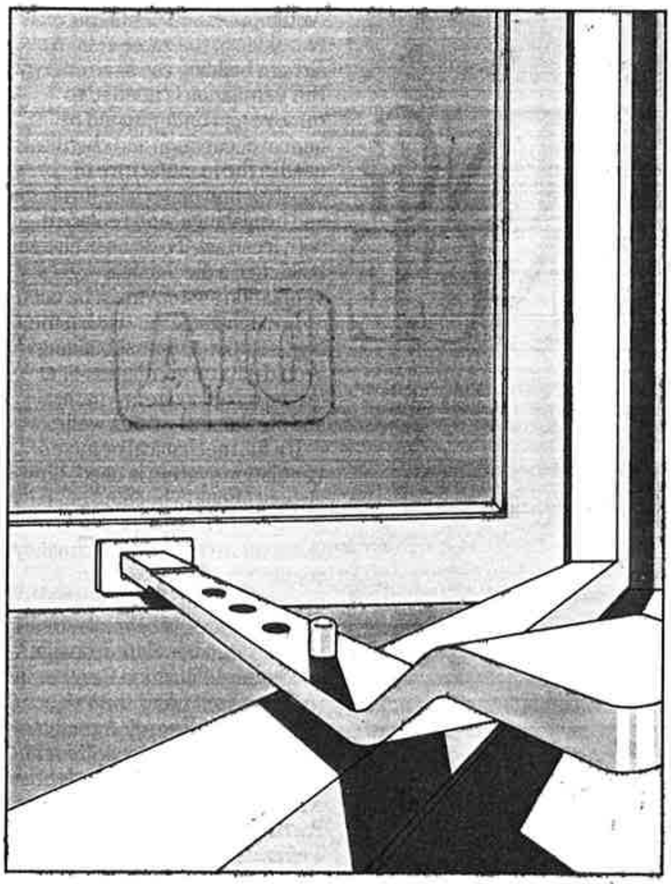
Letting off Steam: Test houses with ventilation system for condensation control

50

High and Dry: Condensation in the roof; eaves-to-ridge ventilation

53

Product review: Four pages of related products



VENTILATION IN BUILDING

The In Building series this month looks at ventilation, and how it can help control condensation and indoor air pollution.

IN BUILDING·A MONTHLY SERIES

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History of development; Banks in Hong Kong and Islington

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Office lighting; Supply safety; Mains signalling

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Reducing waste; New by-laws; Lead-free solder; Scale

This is the last feature in the In Building series. Over the past three years the technical series has kept the practitioner up to date on developments and proved a popular and valuable source of information.

In January, a new series of technology special features will begin. The first subject is repair and maintenance of historic buildings, covering diagnosis, brickwork and stonework, mortars and timber decay.

STANDARDS

ACHIEVING A BALANCE

● Getting the right combination of airtightness and ventilation ○ Work of the Air Infiltration Centre ○ Measuring air infiltration by tracer gas or pressurisation ○ Single-cell and multi-cell mathematical models ○ Ventilation to control pollutants in houses
By George Atkinson

Airtightness and ventilation are two sides of the same coin. An airtight building can save energy. But ventilation is needed to remove air contaminated by human occupation and chemicals used in the manufacture of construction materials, furniture and furnishings, and replace it with fresh air. To do so in airtight buildings, a mechanical ventilation system must be used.

Is mechanical ventilation the best solution for most buildings? Would natural ventilation or at least a mixed system – natural and mechanical – do as well?

If a full mechanical or mixed ventilation system is used, how airtight should a building be, if the system is to give satisfaction under all weather and occupancy conditions? Anyway, how airtight are buildings and what allowance should be made for air infiltration in ventilation design?

The Air Infiltration Centre (AIC) was set up by the International Energy Agency to answer such questions. It is run by BSRIA at Bracknell under the watchful eye of the Oscar Faber Partnership, its operating agent. Ten countries – Belgium, Canada, Denmark, Netherlands, New Zealand, Norway, Sweden, Switzerland, UK and USA – have been supporting the work, and were recently joined by West Germany and Finland.

AIC has three principal tasks:

☐ To help towards a better understanding of the complex processes of air infiltration.

☐ To improve the accuracy of techniques for predicting air infiltration, and associated energy consumption, indoor air quality and airborne moisture migration.

☐ To promote the proper application of energy saving measures to new and existing buildings, while ensuring a safe and healthy indoor environment.

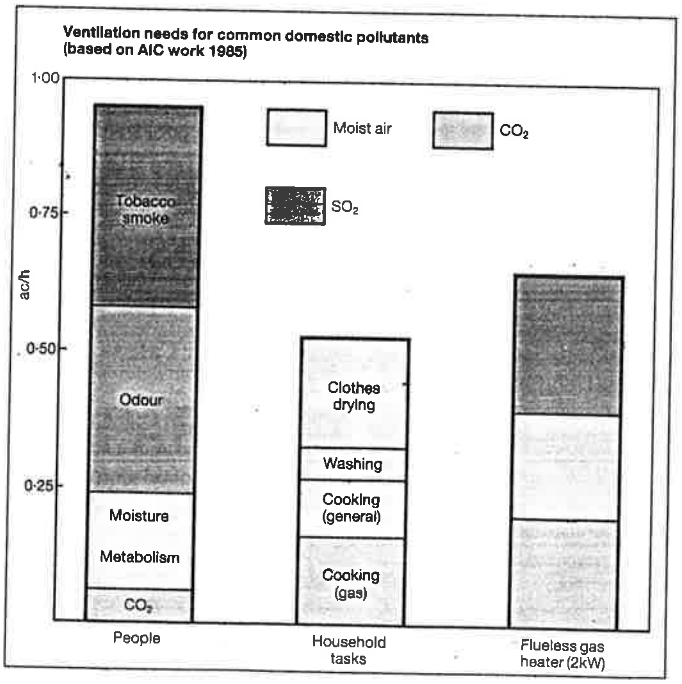
AIC carries out these tasks in several ways. It gives expert technical advice and information in response to specific enquiries and undertakes analytical reviews of relevant literature, using the facilities of a specialist library on air infiltration and associated topics. It runs a computer-based data storage and information retrieval system, AIRBASE, and organises appropriate study workshops as well as an annual conference.

Exchanging experience

A major task for AIC is to encourage the exchange of experience between researchers on experimental techniques for measuring air infiltration, and the associated development of instruments. Measurement techniques fall into two broad groups: those which use a tracer gas, its rate of decay giving a direct measure of the rate of air infiltration at the time of the experiment; and those which apply pressures to parts of the fabric, enabling movement of air through a construction to be observed.

The tracer gas method provides the only real method of measuring fresh air change rates due to natural ventilation. The gas used must be readily detectable at the very low concentrations which develop as it mixes with fresh air. Mixing should be perfect and instantaneous. The gas should, of course, be harmless.

Factors influencing air infiltration, for example wind,



must remain unchanged during the experiment, therefore measurements usually cannot go on for more than one or two hours, too short a time for equilibrium to be reached in a tight building. A second drawback is that, being dependent on the weather and other external factors, single measurements are of limited use.

This snag is being overcome by automating release and detection of a tracer gas, which, however, requires more complex instrumentation.

Tracer gas measurements are time-consuming. The alternative – pressurisation – has the advantages of flexibility and greater speed in obtaining results. Techniques are of three kinds: pressurisation of a whole building; leakage testing of single elements in situ; and conventional testing of components, such as windows, in a laboratory rig.

Since the mid-1970s, BRE has used a simple pressurisation technique to measure the air infiltration performance of small houses. A portable fan unit is sealed into an external door opening, and a pressure difference – usually in the range 20-60 Pa – is applied across the house's external envelope. By measuring the flow rate at each pressure difference, a characteristic air leakage curve for that envelope is developed. Precautions have to be taken to minimise external effects such as strong wind. Similar techniques using more powerful fans have been used in Canada to measure air leakage in larger buildings such as schools and supermarkets.

Ventilation systems: the options

System	Advantages	Drawbacks
Natural: open window, slot ventilator, flue or air duct using stack effect	Simple – no moving parts to maintain, electric power not needed.	Depends much on weather – wind speed and direction, and temperature differences; also on sensible operation by occupants. May be a cause of draughts, eg in open offices affecting those near windows particularly. No control over outdoor noise.
Natural: with control related automatically to wind and/or temperature conditions	Low cost improvement on uncontrolled system.	Difficult to design where building leaky and/or driving forces small. "Effects of such systems on ventilation and energy consumption not yet sufficiently documented."
Mechanical: exhaust only	Lowered internal air pressures mean less risk of moisture transfer through building fabric. Relatively low cost. Correctly sized installation in airtight building and well-sited air inlets can give good service.	Ventilation depends on fan speed and location. Risk of poor ventilation where air leakage unevenly distributed with big leakage near fan. Ducts, etc, need periodical cleaning.
Mechanical: supply and exhaust	Excellent control over ventilation in airtight buildings. Supply air can be filtered and heated. Heat recovery can be fitted easily to exhaust air.	Expensive to install in an existing building. Fan noise may be a problem. Building needs to be airtight. Ducts, etc, need periodical cleaning.

(Based on AIC Report D2:1983)

Mathematical modelling

AIC is also active in the development of mathematical models of air infiltration and ventilation. Researchers in a number of countries are using models which range in complexity from single-cell, in which the interior space in a building is assumed to be at uniform pressure throughout, to multi-cell techniques in which the space is sub-divided into zones of differing pressure interconnected by leakage paths through gaps around doors, etc.

For validation and comparison, ten models developed by researchers in five countries, including the BSRIA (LEAKS), British Gas (VENT) and BRE models, were selected. From experimental measurements of air infiltration obtained from 14 dwellings and associated climate data, three key data sets were constructed: from an isolated, detached timber-frame dwelling in Switzerland; a similar dwelling in Ottawa, Canada; and a naturally ventilated, three-storey mid-terrace house at Runcorn.

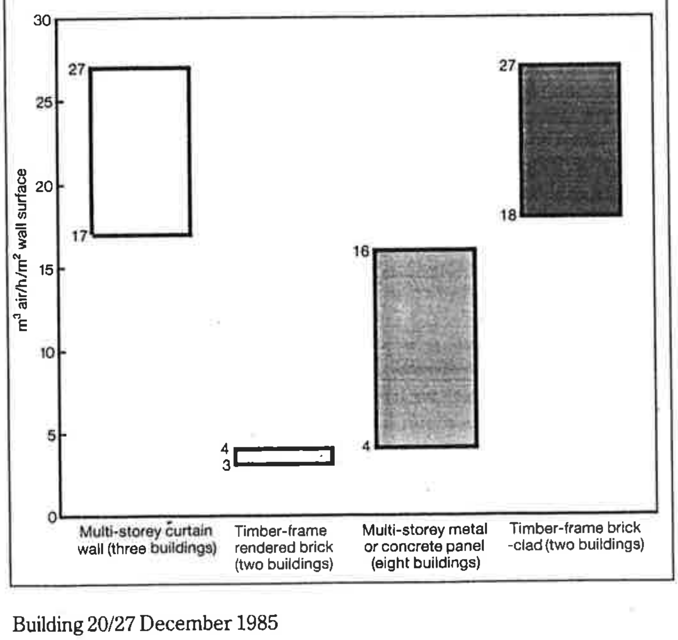
The models' performance was evaluated against data from each of the three sets. The results, described in detail in AIC Technical Note 11, showed that, generally, computations were within ± 25% of the measured air infiltration rate, regarded as an acceptable tolerance.

On windy days and on exposed sites, particularly where there is a mix of tall and low buildings causing turbulence, the most difficult parameter to quantify is the wind pressure distribution. Data from wind loading (BRE Digests 119, 283 and 284) appears to be inadequate. It seems, however, that air infiltration calculations are "fairly insensitive to variations in pressures of under 20%".

Comments on the comparative advantages of the four UK models are given in the AIC Technical Note. For simple applications, the one-cell BRE model gave "consistently accurate predictions".

The next stage is the preparation of an applications guide aimed at providing technical guidance on the calculation of air infiltration rates, and the assessment of energy implications.

How airtight are buildings? (From BRE Information Paper IP 14/79)
Measured data from buildings in Norway and USA converted to a standard pressure difference of 200 Pa



Controlling pollutants

Ventilation is needed to control pollutants. Their severity in housing is closely linked to lifestyles – and income – a fact known to Victorian sanitarians and largely forgotten during the 1960s. This was because tuberculosis, the scourge of Edwardian Britain and allegedly caused by poor ventilation, had been eliminated. The Egerton Committee had shown how wasteful of energy the traditional open coal fire was (ac/h rates of 4.5 or more).

The problem was, and still is, that those households less able to afford heating are those who need abundant ventilation. A "perfect" family of non-smokers, who bath regularly, use deodorants, have a tumble-drier vented outdoors, extract fans in the bathroom and above the cooker, and central heating served by a balanced-flue gas boiler or electric storage, may find 0.5 ac/h acceptable. Treble that rate will not be enough for a family of smokers with many children in a rented flat, with no heating other than a flueless kerosine stove, and no facilities for clothes drying.

AIC, by bringing together practical experience and experimental data for many sources evaluating techniques for assessing airtightness of buildings and their ventilation, and in the application guide now in active preparation, provides the tools which enable designers to choose the right combinations of airtightness and ventilation systems●

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VENTILATION IN BUILDING

INDOOR POLLUTION

HOUSE FULL OF HORRORS

● Lower ventilation rates increase air pollution risks in homes ○ Asbestos and formaldehyde are not major problems ○ Insulated dry lining can help eradicate mould growth from condensation ○ Tobacco smoke hazards – no simple answer ○ Progress made in tackling radon

By Robert Matthews

Building scientists are beginning to realise that as the houses we build become more sophisticated, the characteristics of their performance have a nasty habit of being related to each other. Improve them in one way, and they instantly get worse in another.

The most disturbing example of this is indoor air pollution. Lowering ventilation rates in homes seals in more than heat alone: toxic chemicals, often at levels far higher than those outdoors, are trapped as well.

The air within even a relatively well-ventilated house is a cocktail of gases, particles and vapours, ranging from relatively harmless water vapour to cancer-causing organic compounds present in cigarette smoke.

Researchers are still finding out about the health effects of these chemicals, both on their own and in combination. So far, attention in the UK has focused on a small "rogues gallery": these are formaldehyde, oxides of nitrogen and carbon, asbestos, fungal spores, cigarette smoke and radon.

The good news is that not all of these are killers. The bad news is that doing anything about those that are may need a change in the way we build houses.

Concern about indoor air pollution in the media has not always been well founded; the scares over formaldehyde[1] and asbestos in homes[2] are examples.

The fact is that levels of formaldehyde, NO_x, CO and asbestos found in the average home are just not high enough to cause long-term serious harm to occupants.

Formaldehyde generated from curing uf cavity insulation, chipboard, carpet glues and other materials may reach levels high enough (about 0.1 part per million) to cause eye and nose irritation in some susceptible people. Such levels are, however, *hundreds* of times lower than those needed to cause major illness, and tail off anyway as the source loses its strength.

Oxides of nitrogen and carbon are generated by combustion in, for example, gas cookers and cigarettes. Health effects have been reported by researchers both here and in the US for young children living in homes with gas cookers, but these have not been fully confirmed. Carbon monoxide, the gas that kills when accidents occur with faulty gas appliances, does not appear to exist in homes at levels likely to have significant health effects.

However, as both these oxides have a potentially continuous source in homes with gas cookers, it is vital that adequate ventilation is supplied for the appliances to operate properly. Despite constant warnings from British Gas, overzealous draughtproofing still takes place, especially as this energy-saving measure is generally thought of as a diy job.

House designers must always emphasise the vital necessity of keeping ventilation slots unblocked, and specify a ventilation system that is as tamper-proof as possible. Makers of draughtproofing must also do more than say "don't overdo it": specific guidance on how big a gap to leave and where should be given.

Asbestos, an undoubted cause of lung cancer and other diseases among those unprotected from high levels, is again not a major pollutant in the home, unless it is seriously disrupted. Fibre levels, even in those buildings containing damaged asbestos, are hundreds of times lower than occupational levels. The risk from such levels is virtually nil, according to a study by leading cancer experts Sir Richard Doll and Professor Julian Peto published earlier this year[2].

Three real dangers

It is a different story with three specific pollutants: fungal spores, tobacco smoke and radon.

Condensation blights about 1 in 10 homes in the UK building stock, particularly ageing, poorly insulated dwellings. The mould that results is very unsightly, but as the Institution of Environmental Health Officers recently made clear, the problem is more than cosmetic.

A report by the IEHO published in October[3] blames mould growth and the fungal spores generated by it for allergies and illnesses including asthma, rhinitis and conjunctivitis. Even small concentrations of spores can prove harmful, attacking those already suffering from diabetes and leukaemia. The health effects of fungal spores caused by excessive condensation have already been at the centre of litigation, and more may follow soon.

Dealing with the problem is likely to create a large market for the makers of insulated dry lining and external wall insulation. Many of the affected homes do not have cavities which can be insulated, and insulation is in general the best answer, combined with extra ventilation in high risk areas such as kitchens and bathrooms.

Tobacco smoking is a prodigious source of toxic chemicals, and a proven cause of cancer. It is also suspected of doubling the lung cancer risk of non-smokers. Add to this the short term irritants that cigarettes throw out, and designing, say, a bar-room to include a substantial number of smokers becomes a major task.

This is because both the Chartered Institution of Building Service Engineers and its American counterpart ASHRAE recommend very high fresh air rates (around 18 ac/h for bars and the like). Producing a low energy building under these circumstances is not easy, especially as some claimed solutions are not as effective as they may appear[4]. Some form of heat recovery is a virtual necessity.

Radon threat

Perhaps the most controversial indoor pollutant of them all is radon, the radioactive gas that seeps into buildings from uranium-bearing ground below[5].

A national study into levels of this cancer-causing gas in UK homes has been carried out by the Government's radiation watchdog, the National Radiological Protection Board. The full results will not be published until the new year, but the preliminary results are disturbing enough[6].

About 1 in 20 homes in Cornwall contains levels of radon at doses higher than the maximum recommended last year by the Royal Commission on Environmental Pollution[7]. The NRPB also found homes with radon doses over ten times higher still.

Such high levels are the result of the high uranium content of soil in parts of the South West. Nationally, levels are on average 20 times lower than for Cornwall. Even so, the NRPB estimates that 100 000 existing homes may have to be studied to see if action must be taken.

The Government has been quick to recognise the need to tackle the radon problem before it is made worse by the lower ventilation rates in today's low energy homes. Energy efficient and cost effective ways of lowering radon doses have been studied by the NRPB in a special granite test-house in Cornwall; the results to date are very encouraging.

For new homes, avoiding sites with uranium-rich soils is important, but a carefully installed impermeable barrier laid above a ventilated floor space seems to be the answer. Most radon enters the house from below, so sweeping it away before it enters the room, and putting a barrier up against any that survives appears to lower radon concentrations to safe levels.

For existing homes, many of which do not have ventilated floors, the NRPB found that getting an adequate seal around the perimeter of a barrier laid into the floor was impossible.

However, trials using a Swedish-designed suction pump, which literally sucks radon out of the ground below and blows it into the outside air, worked very well indeed. The main drawback is the need for a 30 W fan to drive the system.

Technology does exist

It is only recently that indoor air pollution has really caught the interest of building designers in the UK. They are somewhat behind their counterparts in the US, who are already being threatened with legal action if they create a "sick" building.

But the new building regulations now mention the need to prevent indoor air pollution in new buildings[8], so the time to improve matters is here.

The recent controversy over health effects has tended to overshadow the work that has been going on to find ways of dealing with the problem. The results so far show that the technology, at least, exists to deal with the principal ones in an energy efficient way.

Unfortunately, researchers are finding that not all cases of sick buildings can be blamed on individual pollutants[9]. What appear to be insignificant amounts of individual pollutants combine together to produce very serious health effects. Finding a simple, energy efficient way of tackling this problem is still far from easy●

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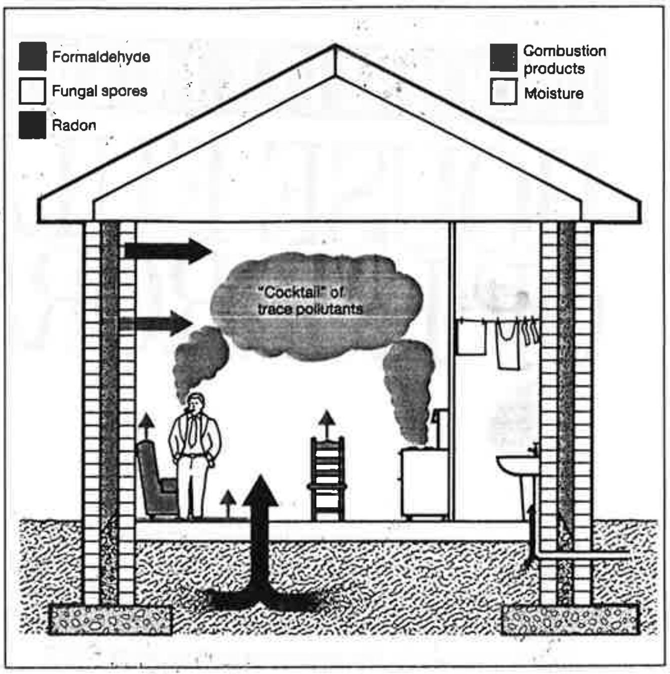
5. "The enemy within", *Building* 29 April 1983, page 26.
6. *Building* 30 August 1985, page 7.
7. *Building* 24 February 1984, page 9.
8. *Building* 31 May 1985, page 8.
9. *Building* 6 September 1985, page 73.
10. An excellent reference book is *Indoor air pollution* by R Wadden & P Scheff, Wiley Interscience, 1983. It should be read in conjunction with CIBSE Guide B2 and NRPB reports R-152 and R-159 on ventilation standards and radon in the UK.



Top right: Small amounts of individual pollutants can combine together to produce very serious health hazards.

Indoor pollutants: typical levels and recommendations

Pollutant	Location	Typical levels	Recommendation
Radon (Rn)	All buildings	0.8 millisieverts	5 mSv inquiry level (NRPB)
Carbon monoxide (CO)	Offices, bars, gas-stove kitchens	15 ppm 5.5 ppm	9 ppm for 8 hr or 35 ppm for 1 hr no more than once per year (EPA)
Nitrogen dioxide NO_2	Gas cooker homes	0.16 ppm	0.05 ppm annual mean (EPA)
Total suspended particulates	Homes, public buildings	53 $\mu g/m^3$	75 $\mu g/m^3$ annual geometric mean (EPA)
Asbestos	Normal activity	5×10^2 f/m^3 (Doll and Peto)	5×10^5 f/m^3 for white (occupational) (HSE)
Ozone (O_3)	Photocopiers, homes with electrostatic air cleaners	0.04 ppm 0.01 ppm	0.12 ppm for 1 hr no more than once a year (EPA)
Formaldehyde (HCHO)	Homes with chipboard	1 ppm (temporary)	2 ppm (occupational) (HSE)

NRPB: UK National Radiological Protection Board, July 1983
EPA: US Government Environmental Protection Agency 1971-79
HSE: UK Health and Safety Executive, 1984. Levels for brown and blue asbestos are 2×10^5 f/m^3.
R Doll, J Peto, HSE report, April 1985.

CONDENSATION CONTROL

LETTING OFF STEAM

● Passive ventilation system installed in four houses ○ Provides a consistent background ventilation rate ○ Cooking smells and steam clear quickly ○ No conscious attention is necessary ○ Recommended for use as part of an integrated design for condensation control

By Ken Johnson

A new domestic ventilation system developed by Pilkington Brothers and TRADA has been installed and is in use in four houses built by Laing near Southampton. The system is a passive one, using simple extraction ducts leading up from the kitchen and bathroom and ending in the loft just below a tile ventilator; trickle vents are fitted to all window heads. The inside to outside temperature difference (the stack effect) and the wind induce air flows out of the house through the ducts.

The system has been refined over a number of years, and the object of the current phase of work was to see how well it would perform in practice in occupied houses over a winter period. The views of all four households were sought, and one house was monitored for air flows through the ducts as well as being checked for airtightness and infiltration.

The monitored system performed remarkably well, especially considering its simplicity. During the winter, there was usually sufficient stack effect or wind effect to "drive" the system at a rate suitable for the house. For example, in a 16-day period in March, outside temperatures varied from −3 to +14°C (with the inside at a fairly constant 18°C) and the wind from 0 to 10 m/s. Flows in the ducts produced, on average, 2.5 and 2.0 ac/h (air changes per hour) in the kitchen and bathroom respectively, equivalent to 0.45 ac/h for the house. For 91% of the time, air change rates were between 0.3 and 0.6 ac/h for the house.

A significant part of the period when flows were outside the above range was caused by low flows in the bathroom duct on two particular days, (the flows in the kitchen duct also dropped, but less significantly). The drop in performance corresponds to periods when it was warm and calm outside, and when the window vents were shut (as part of an experiment).

No overextraction

At no time did the system overextract. It is thought that this is due to the pressure/flow characteristics of the ducts and the "decoupling" of the ducts from the wind by ending them short of the tile ventilator. The greatest driving forces were logged on one day in February: a temperature difference of 23.5°C at the same time as a wind of 7 m/s produced only the same flows in the kitchen duct as the average for the March period.

Clearly, while air is leaving the house via the ducts, the normal through-house ventilation would be occurring as well. Carbon dioxide decay tests carried out with the ducts sealed off had indicated a very tightly constructed house with an air infiltration rate of only 0.15 ac/h with about 15°C temperature difference and average wind. The rate increased to 0.3 ac/h under the same conditions with the window vents open and to 0.6 ac/h with little temperature difference, a strong wind and window vents open.

If the two effects are now combined, a total rate of 0.6 ac/h can be expected for the house under average winter conditions if the window vents are kept shut. The effect of opening the vents is somewhat complex, but in general the system is "user friendly".

If it is very cold and windy outside, the system will be extracting at or near its maximum, and the status of the window vents will have little effect on the flows. Opening of the vents would allow an increase in the normal through-house ventilation, but with those outside conditions, the occupier is likely to shut vents, keeping the total air change rate for the house near to 0.6.

At the other end of the scale, when it is warm and calm outside, the duct flows drop, particularly in the bathroom, but this is when the window vents are shut. With these outside conditions, which correspond to nicer weather, the occupier is likely to open the window vents (or even the windows). This will counteract the drop in duct flows, again particularly in the bathroom, but without significantly increasing the normal through-house ventilation rate as driving forces are low, keeping the total air change rate for the house again near to 0.6.

The result is a house with a fairly consistent and continuous overall air change rate.

In addition, air flows are definitely rerouted, with direct extraction from the moisture producing areas, reducing spread of moisture to other rooms. Closing of doors reduces duct flows slightly, but since they also block the spread of moisture, the effect is thought to be unimportant.

Previous tests showed that the local heat from a cooker increased the extraction rate in the kitchen. It now seems likely that this effect will only occur under the conditions of low driving forces (which would be useful) since under high driving forces, extraction would already be at or near the maximum possible rate.

The ducts in the three non-monitored houses, and initially in the monitored house, were fitted with inlet registers which close in the event of fire; the results above are with the registers removed. It was found that the particular design and size chosen throttled duct flows significantly. If it is considered that some device to prevent spread of fire is necessary, then a detail redesign such as an increase in the diameter of the duct ends to allow fitting of larger registers should be sufficient.

At the end of the tests, checks were made on the system: all that was found was a thin layer of dry dust on the walls of the kitchen duct. No condensation had been found on the roof tile vent during the tests, nor was there any evidence that there had been any at the final check. There were no signs of condensation having occurred in the ducts themselves.

No conscious attention

The overall reaction from the four households was that they had not really noticed or thought about the system until the interview, which on investigation meant that they had rarely considered opening or shutting windows or vents in relation to cooking smells or steam, and that there were no significant annoying side effects. Encouragingly, they all said that they had generally "forgotten" about the system.

It was apparent that window vents had generally been left open except during very cold or very windy weather, following which they had been reopened. No back-draughts had been noticed from the ducts, and noise associated with rain and aircraft was not significant. Cooking smells and steam had cleared quickly, as had tobacco smoke. In the monitored house, there had been test periods with the ducts and window vents sealed off: the occupiers commented on lingering cooking smells, smoky conditions and excessive window condensation when the ducts were sealed, whether or not the window vents were open.

These results are extremely encouraging, and a passive system may well be the significant step forward needed to apply a fully integrated approach to designing or rehabilitating houses for condensation control. It is very important to emphasise that the introduction of a ventilation system in isolation is unlikely to solve problems of condensation or energy loss any more than any other single measure.

What is needed is a tightly draughtstripped house with the walls, windows, roof and floor all insulated to a high standard, fitted with an appropriate heating system and some means of providing and controlling the ventilation rate.

The passive ventilation system described does not have the high extraction rates of mechanical fans, but it does operate continuously throughout the winter season. It is self-controlling to some extent, is quiet and cheap and does not require control gear or deliberate attention. It works in sympathy with the occupiers' expected actions. It should provide the balance needed between stuffy, condensation-prone conditions and excessive energy loss, if used as part of an integrated design●

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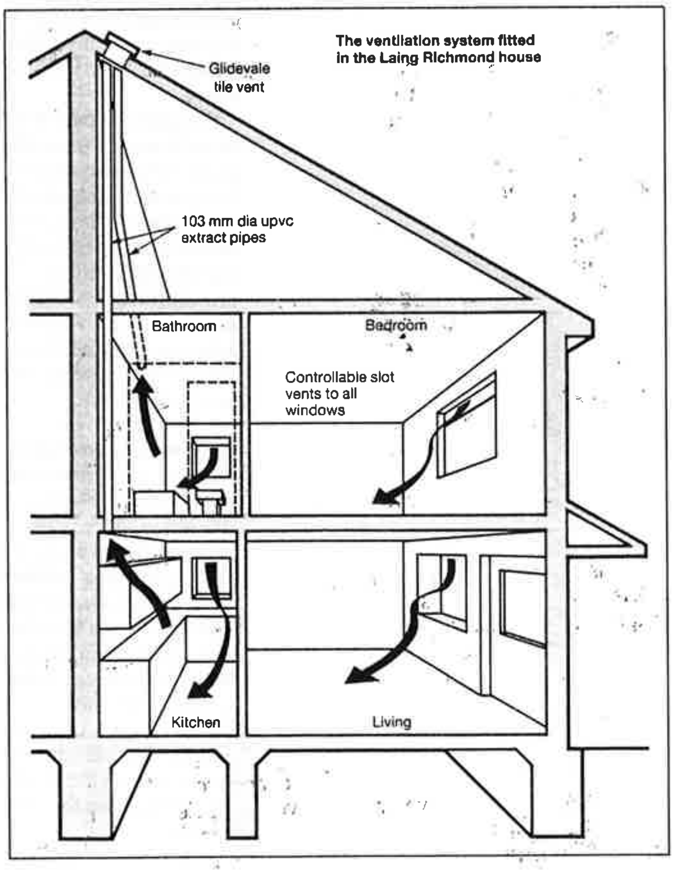
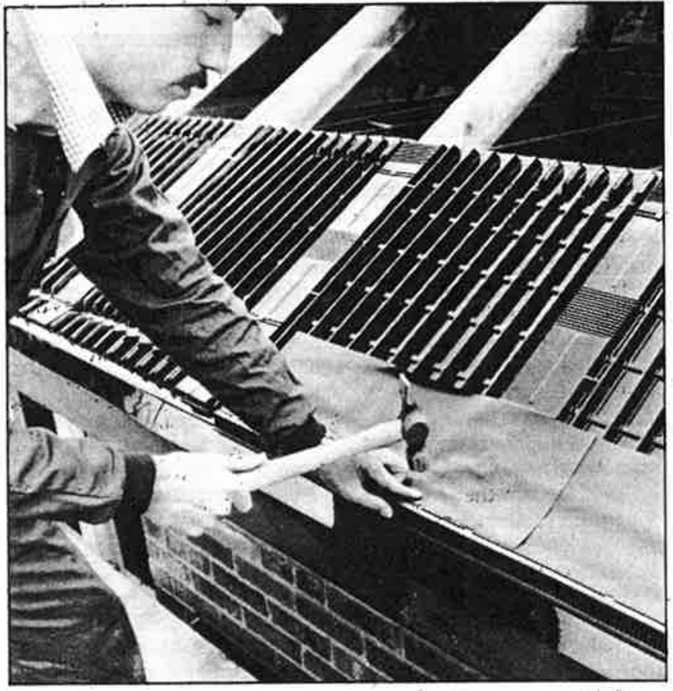
Ken Johnson works for the buildings and energy section of Pilkington Brothers. This article is abbreviated from his paper, the full version of which is available from Pilkington Brothers or TRADA.



ROOFS

HIGH AND DRY



Redland RedVent eaves ventilators being installed.

● Condensation risks in the roof space ○ Natural ventilation can minimise the problems ○ Redland's RedVent system ○ In certain constructions, eaves-to-ridge ventilation may be necessary ○ High level ventilation openings with ridge systems or ventilating tiles

By Alan Dodds

In the dwelling, mechanical extract systems can be used in areas of high condensation risk such as bathrooms and kitchens. In the roof space, an area of increased condensation risk, natural ventilation is recommended.

With the upgrading of insulation standards in existing buildings there may also be a need to introduce some form of ventilation system, and in these cases the ease of fixing of terminals must also be taken into account.

The condensation risk within the roof space is dependent on many factors, not least of which is the amount of water vapour generated by the dwelling occupants. BS 5250:1975 suggests that typical moisture generation within a five-person dwelling varies from 12.6 pints per day to 25.2 pints per day.

The presence of a vapour control layer at ceiling level and the size and number of all openings around loft hatches, pipes and wiring ducts all affect the amount of this water vapour that can reach the roof space. It should of course be remembered that the less water vapour allowed to enter the roof space, the more will remain in the dwelling area and will need to be vented in some other way.

Other factors that vary the risk of roof space condensation include the size, shape and pitch of the roof and the amount of insulation present at ceiling level. It has been predicted that the current U-value requirement for roofs of 0.35 will be reduced to 0.15 within ten years. This will have the effect of increasing the current insulation thickness required from 100 to 250 mm.

The best way of minimising the risk of roof space condensation in the light of these variable factors is by natural ventilation. BS 5250:1975 states that, for roofs above 15° pitch, ventilation openings equivalent to a continuous opening of 10 mm should be provided along two opposite sides of the building at low level.

There are a number of ventilation products on the market. The Redland RedVent eaves ventilation system, for example, provides a continuous rafter tray designed to prevent blockage of the opening by thermal insulation. At the same time, it maintains the function of the roofing underlay by providing an anti-ponding support and an overlap into the gutter. A fascia grill unit has an opening gap size of 4 mm, preventing the entry of large insects and yet minimising the air resistance. This resistance is something not often considered when designing or installing ventilation openings. If close fitting, small screens are used, the ventilation rate will be less at a given wind speed than if an unobstructed path is used.

Eaves-to-ridge

In many cases, eaves-to-eaves ventilation will probably be adequate in eliminating the condensation risk. However, the risk is dependent on roof size, shape and pitch. This is recognised by BS 5250 when it stresses that the 10 mm gap at eaves is only a minimum and that there are advantages with certain constructions in increasing the ventilation provision in order to achieve air movement throughout the roof void. Roof pitches in excess of 20° or roofs having spans greater than 10 m should have high level ventilation equivalent to a 3 mm continuous gap.

High level ventilation is required on lean-to and mono pitch roofs equivalent to a continuous opening of 5 mm. Eaves ventilation openings should be provided at the steep side of mono pitch roofs. The only way of achieving this is by air bricks or other proprietary wall ventilators.

The superiority of eaves-to-ridge ventilation is highlighted in the worst situations – when there is no wind acting or when the external air flow is parallel to the ridge. In the first case, thermally induced ventilation will still occur, while in the second, negative pressure at the high level openings will draw air through the low level ventilation openings. This is confirmed in the recent British Board of Agrément Certificate 85/1461 covering the Redland RedVent range of roof space ventilation products. It states that "in terms of ventilation efficiency, eaves-to-ridge ventilation is more efficient than eaves-to-eaves ventilation".

One point to note, however, is that high level ventilation openings must always be provided in conjunction with low level openings. If no low level openings are provided, the same suction force that improves the eaves-to-ridge ventilation could increase the transfer of moisture to the roof space.

Ridge ventilation

There are two methods of providing high level ventilation openings, each having particular advantages in different circumstances. These are a continuously ventilated and dry-fixed ridge system or a ridge ventilation terminal or, alternatively, tile ventilation terminals at high level on the roof slope.

The Redland DryVent ridge system provides high level ventilation in an unobtrusive way. Ventilation openings are provided by upvc grill/filter units which also provide a mortar-free filling between tile and ridge. Air flow control units isolate the batten cavity, maintaining the function of the underlay and ensuring correct and efficient ventilation of the roof void. The ridge tiles themselves are nailed to the roof structure enabling the resistance to wind uplift to be accurately calculated.

As an alternative, the RedVent ridge ventilation terminal has an opening area of 8400 mm^2 so that one unit every 2.8 m of ridge will provide the equivalent of a 3 mm continuous gap. The terminal is supplied already fitted to a standard ridge tile which blends in well with the ridge line. It can be fitted at the time of roofing or at a later date should problems arise.

RedVent ThruVent ventilating tiles can be fitted at any point on the roof slope to provide ventilation. This versatility is of particular importance for mono pitch roofs or non-regular shaped buildings where stagnant air pockets can occur ●

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