# An airtight case for green building

If you live in a typical UK home, expensive, heated air is constantly escaping, making your fuel bills unnecessarily high, giving rise to uncomfortable draughts and damaging the environment. **Paul Jennings** reports ...

Elsewhere in this book, you will read plenty of tips and hints about how best to increase insulation levels and reduce energy losses through the fabric of your building. However, regardless of how much insulation you put in, if you fail to address air leakage – i.e. draughts – your energy-saving expectations will never be fully realised. Sustainability is ultimately about reducing the carbon dioxide emissions that are causing global warming and driving climate change, giving us increasingly extreme and unstable weather conditions. As insulation levels continue to increase, an ever greater proportion of energy losses from our homes will occur through air leakage. If you don't address air leakage you might as well rip this book up and stuff it in the cracks!

## The science of draughts

Draughts are uncontrolled air movement – and they make us uncomfortable. The wind blowing on our buildings can force cold air in, around windows and doors and through a wide range of other gaps and openings, or warm air rising within our homes escapes at high level creating a suction which pulls cold air in through these same holes. Neither is satisfactory, yet at the same time we always need ventilation in our buildings to provide a healthy living environment.

We often tolerate draughts because we think they provide the necessary ventilation – wrong!! Draughts are uncontrolled currents of air whilst ventilation is controlled and deliberately induced, using openable windows, trickle vents, extract fans etc. Most UK buildings have too much air leakage (draughts) when the wind blows and not enough ventilation on calm, still days.

Ventilation is the controlled replacement of degraded indoor air with external air and all buildings need ventilation. We need ventilation to breathe, and we need ventilation to get rid of indoor pollutants – cooking and other smells, but particularly water vapour. Minimising the buildup of moisture helps prevent condensation and mould growth, and discourages dust mites. A relative humidity of between 50% and 65% will provide the most comfortable and healthy living environment. If we have open flued appliances, such as wood-burning stoves, we need more ventilation for safety, and if people smoke we need lots more ventilation.

## Why minimise air leakage?

As well as allowing costly warm air to escape, air leakage gives rise to uncomfortable draughts, degrades the effectiveness of insulation by as much as two-thirds, and allows potentially damaging moisture to penetrate our walls. Air leakage is bad, ventilation is good. The slogan "build-tight, ventilate-right" has been used for several years to encourage us to improve our buildings and reduce this shameful waste. Indeed, it has been suggested that it is impossible to build a building too airtight, although it is clearly possible to fail to design sufficient and appropriate ventilation.

As insulation levels installed in UK buildings have risen, particularly in recent years, then the waste of energy through escaping warm air has become more significant. Fig. 1 illustrates how the proportion of energy lost through air leakage has increased to the point where it can be more than half of all energy losses. This is likely to be even more significant for green designers and builders as they tend to adopt insulation levels substantially above the minimums required by building regulations.

## Airtightness testing

A 'blower door', also known as a 'door fan', is the principle tool used for measuring airtightness

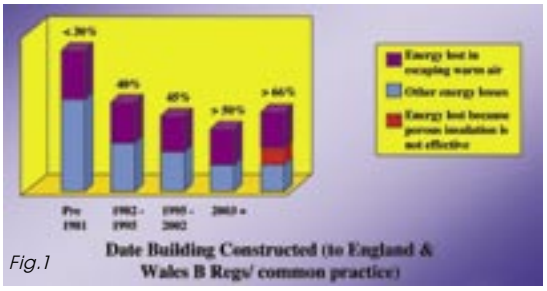


*Fig.1*

and identifying leakage in dwellings and other new or existing buildings. It consists of one or more calibrated fans that are mounted in an open doorway using an adjustable door panel system. A series of steady-state pressure differences are then applied using the fan.

Once steady state conditions have been achieved, the airflow measured through the fan equals the sum of the air leaking through all the different gaps, cracks and openings in the envelope of the building or volume under test, adjusted for temperature difference.

By measuring the corresponding imposed pressure differentials, the leakage characteristics of the volume being tested can be established. Door fan testing is used to:

- provide an acceptance test for new dwellings, offices or other buildings
- identify leakage sites and provide quality control on remedial sealing works, if required
- check the performance of ventilation, extraction or MVHR systems
- establish ventilation rates in existing properties, for example to investigate the cause of condensation problems

## Leakage in buildings

Our experience of testing houses and other buildings across the UK, together with test results published by various national bodies, show that the UK construction industry may well be in for a nasty shock when air leakage testing becomes more widespread.

UK builders, with certain honourable exceptions, have not yet grasped the nettle and learnt how to construct and finish airtight dwellings and other buildings. Yet airtightness requirements are increasingly being included within standard specifications for new developments, particularly in the non-domestic sector, even before the revisions to Part L are finalised. The result can be an uncomfortable squeeze, where builders are required to attempt to remedy leakage problems and carry out additional acceptance tests just before handover – often at considerable (and sometimes unrecoverable) cost.

Test results published by BRE clearly show that improved airtightness in our buildings is essential – UK offices are around 2 to 4 times leakier than equivalent buildings in Scandinavia or North America, whilst industrial buildings are found to be more than 4 times as leaky. In housing, recent experience of testing supposedly airtight timber framed houses encountered many of the same problems found when testing the TRADA low energy house at Energy World in Milton Keynes more than a decade ago!

The leakage sites to be found in dwellings and other buildings can be subdivided into two types:

- structural leakage sites
- services leakage sites

Structural leakage sites occur at joints in the building fabric and around window and door openings. Loft hatches and access openings (usually non-domestic) also fall within this category. There may also be leakage through cracks in masonry walls – poor perpends in blockwork inner leafs being the most common cause – and some diffusion through materials. These are the hardest to retrofix. Good detailing at the design stage is therefore essential. Builders also need appropriate training so they understand how to build airtight buildings to achieve a good test result.

Service penetrations occur where pipes and cables pass into the building. These can be sewerage pipes, water pipes and heating pipes. As well as electricity cables there may also be television aerials and cable television connections. The worst problems tend to occur when these two types of leakage problems interact. Fig.2.

Once there is a failure of the airtight barrier where a hollow intermediate floor is supported from the external wall, a connection exists from a cavity in the external wall (which may be filled

with insulation) through hollow internal partition walls to pretty much the whole of the building. Hollow floors and walls are inevitably used to run services – and just as inevitably tend not to be sealed where the services run from one element into another. The result is that electricity sockets and switches, light fittings (especially spotlights), television aerial and cable television connections, heating and plumbing pipes, waste pipes and soil stacks all become points at which air will leak into the dwelling. Even such minor items as room thermostats and heating controllers will permit air leakage around or through them. Moreover, if one such leakage site is sealed, most of the air will still escape at another site, since they tend to connect and to have a similar resistance to the movement of air through them.

Whilst it may be possible to laboriously seal all these sites and thereby cut the air leakage significantly, cold air will still get into hollow floors and walls, cooling internal surfaces and giving rise to discomfort.

Another major source of problems is the boxing-in of services, particularly water and waste pipework and soil stacks. Also riser shafts in non-domestic buildings. Once services are out of sight it is all too easy for sealing works to be overlooked and forgotten, even if they were specified in the first place. There is no culture of airtight construction on UK sites, and until this is achieved, detailed planning and preparation, rigorous site supervision and air leakage testing will be essential to achieve satisfactory buildings. In fact, air leakage testing provides an effective, rapid and reasonably priced method to check the quality of buildings. ❖

## Resources

*Air testing:* ***www.retroteceurope.co.uk***

*Volume.10 No. 3 of Building for a Future magazine covered the subject of airtightness in-depth including a number of case studies. It can be viewed free of charge at:* ***www.newbuilder.co.uk /bffmag/*** *as a downloadable pdf file or hard copies are available at £5.00 per copy.*

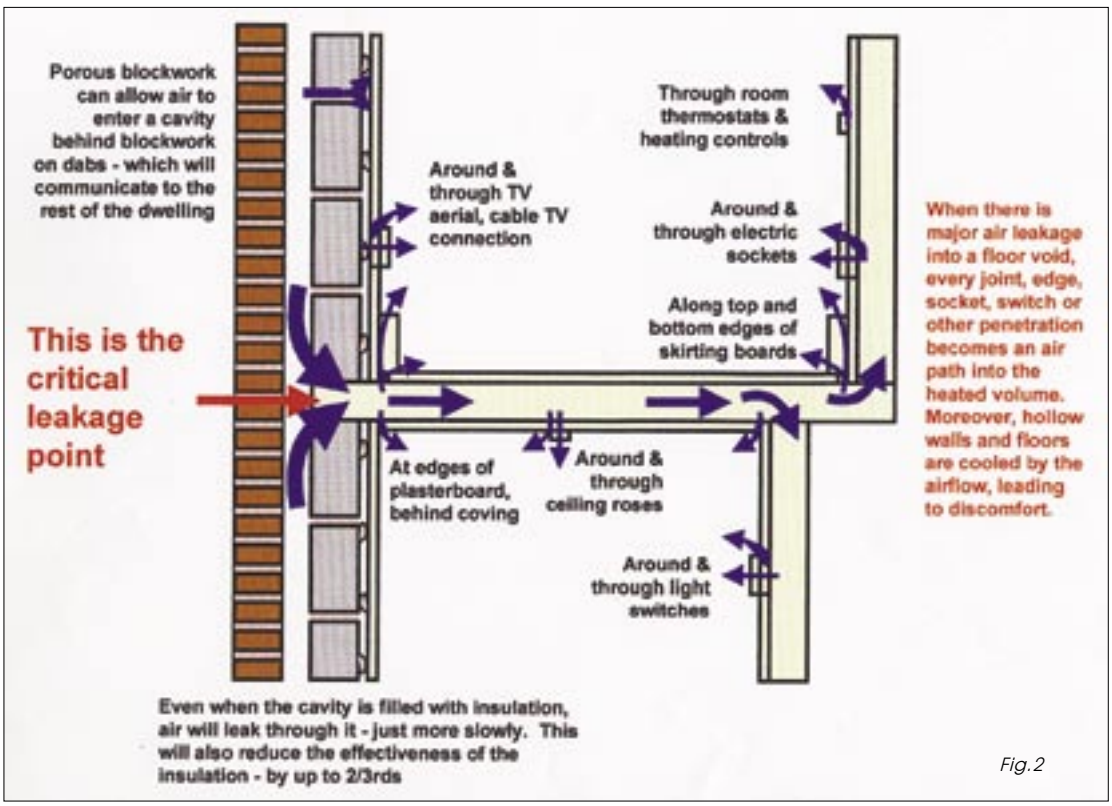


*Fig.2*