Air Leakage & Insulation Assessment

energy imaging

Background

Overseas research shows, and standards recognise, that air leakage control is the most effective method of achieving direct energy savings. The Australian Government's *Your Home: Technical Manual* (2008) estimates that Australian buildings leak 2-4 times as much air as North American or European buildings, suggesting a tremendous opportunity for energy savings in Australia.[1] Our 2008-2009 testing program shows that Canberra houses leak 3-6 times more than North American buildings. Leakage rates in Canberra are equal to 2-4 complete air changes per hour… in winter that means 'goodbye heated air' (energy and money) every 15-30 minutes!

- Air leakage can account for 30% or more of a building's heating and cooling costs.[2]
- 30-50% of the energy used in Australian homes is for heating and cooling.
- Reducing infiltration can significantly cut energy bills and reduce greenhouse gas emissions.[3]
- Insulating materials, such as batt or loose fill products, do not seal against air leakage.[4]
- Uncontrolled air leakage compromises the effectiveness of other, more expensive, energy efficiency measures such new heating systems, window dressings and double glazing.
- Starting with the simple and cost effective approach of air sealing will have the greatest impact on your energy use… and the least impact on your wallet!

Don't get us wrong — insulation is *very* important. We believe improving your building envelope by air-sealing and insulating, *together*, is the most effective thing you can do to reduce your energy use. Installing insulation, *without air sealing*, just doesn't make sense and isn't good practice.

Air leakage, ventilation & indoor air quality

Air leakage is the uncontrolled movement of air into and out of a building (infiltration), which is not for the specific and planned purpose of exhausting stale air or bringing in fresh air (ventilation).

Controlled ventilation is the key for energy efficiency, indoor air quality and building durability. It is achieved by: physically opening windows, doors or other sealable air vents; switching on specially positioned exhaust fans; or using larger and more complex mechanical ventilation systems (standard practice in modern homes in the cold climates of Europe and North America). Random infiltration, or air leakage, should not be considered acceptable natural ventilation because it is not controlled or filtered.

Causes of air leakage

Air moves from areas of higher pressure to areas of lower pressure (air pressure is measured in units called Pascals, Pa). There are three main forces that drive air leakage:

1. wind — exerts constantly-changing pressures on buildings (high on the windward side and low on the leeward, roughly 150-1500 Pa differences).
2. the stack effect — rising warm air causes pressure differences within buildings (lower pressures at the top, higher pressures near the floor, around 5-10 Pa differences).
3. mechanical heating and ventilation systems — create pressure differences within buildings as they heat, cool and move air (5-10 Pa differences).

Any one of these driving forces, or a combination of all three, will lead to air leakage through any cracks or gaps in the building envelope. This leads to cold external air moving into the building, and warm internal air moving out of the building.

[1] Australian Government DEWHA (2008), *Your Home: Technical Manual* www.yourhome.gov.au/technical/fs47.html
[2] US Department of Energy, Office of Building Technology apps1.eere.energy.gov/buildings/publications/pdfs/building_america/26446.pdf
[3] US Department of Energy (2005), *A Consumer's Guide to Energy Efficiency and Renewable Energy* apps1.eere.energy.gov/consumer/your_home/insulation_airsealing/index.cfm/mytopic=11240
[4] US Department of Energy (2005), *A Consumer's Guide to Energy Efficiency and Renewable Energy* apps1.eere.energy.gov/consumer/your_home/insulation_airsealing/index.cfm/mytopic=11250

www.energy-imaging.com.au, info@energy-imaging.com.au
02 6161 9035, 0424 635 082

Impact of air leakage on energy use (& in relation to R values)

It does not matter how thermally resistant a building material is (low U value) or well insulated it is (high R value), if air is able to flow through gaps between building materials then energy efficiency is lost and durability compromised. It is widely accepted in Europe and North America that there is little point in improving the effective U or R (R = 1/U) value standards required for buildings unless levels of uncontrolled air leakage are significantly reduced. For example in the UK, the significant energy loss caused by uncontrolled air leakage has been recognised within amendments to their Building Regulations of 2006. These amendments introduce maximum envelope Air Leakage Standards for domestic and non domestic buildings.

Other impacts of air leakage

As well as direct energy loss, other problems associated with air leakage include:

- discomfort for residents due to drafts
- degradation of building materials due to moisture (carried by warm rising air) condensing within the building envelope, eg. in wall and ceiling cavities
- poor indoor air quality due to fumes and dust entering the building
- potential sites for ember entry during bush fires
- difficulties in balancing air conditioning and ventilating systems

Air leakage testing with a blower door & thermal camera

A blower door is a diagnostic tool designed to measure the airtightness of buildings and to help locate air leakage sites. It includes four components: a calibrated fan, an expandable door-panel system, a sensitive gauge to measure fan flow and building pressure, and tailored computer software.

The fan is sealed into an exterior doorway with the door-panel system and then used to draw air out of the building, creating a pressure difference between inside and outside. This pressure difference causes air from outside, at higher pressure, to move into the building through all the gaps in the building envelope. The tighter the building (eg. fewer gaps and cracks), the less fan speed needed to create a change in building pressure. The pressure gauge and computer are used to regulate, and record, air flow and pressure differences.

Using a blower door, many large leaks will be detectable by simply feeling with your hands. However, the ideal technique for locating areas of air leakage is to use an infrared or thermal imaging camera in combination with the blower door. This involves performing two infrared scans from inside the building; one before turning on the blower door and one after the blower door has been depressurising the building for about 10 minutes. As long as the air being drawn in through the leaks is warmer or cooler than the interior of the house, the area surrounding the leakage path will change temperature and show up on the thermal image. Even if there is little temperature difference between inside and outside, an infrared scan can be still effective as sub-floor spaces are generally cooler, and roof spaces generally warmer, than the external air temperature. This technique allows you to find significant, and otherwise undetectable, leaks without having to enter the roof or floor space.

Thermal imaging lets you view infrared energy (basically the heat radiating from an object) which is not visible to the naked eye. The warmer an object is the more infrared energy it radiates. The thermal camera captures images of the infrared energy given off by the surfaces in your home and shows where temperatures vary by displaying different temperatures as different colours.

Checking insulation with a thermal camera

Independently of the blower door system, a thermal camera can be used to rapidly determine where insulation is missing or improperly installed. Just small gaps in insulation can reduce its effectiveness by 50%.[5] Our testing in Canberra suggests gaps in insulation totalling 5% or more are common.

[5] US Building Performance Institute (2007), *Effective R-values for Batt Insulation* http://www.bpi.org/documents/Yellow_Sheet.pdf

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