CHANGING THE AIR INDOORS

New houses are becoming increasingly airtight as building technology changes. BRANZ research has been checking whether houses are getting sufficient ventilation to maintain healthy indoor air quality and control moisture.

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Ventilation plays a major role in indoor air quality and moisture management in houses, removing and diluting contaminants, including water vapour. Ventilation comes from three sources:

- Infiltration through the building envelope, which depends mainly on the airtightness of the building and exposure to wind.
- The actions of the occupants, such as how often they open windows.
- The operation of mechanical ventilation systems.

Building Code requirements

In New Zealand's temperate climate, opening windows has always been thought to provide most of the ventilation. For this reason, New Zealand Building Code requirements for home ventilation have been for the opening window and door areas in the building envelope to meet or exceed 5% of the floor area.

Figure 1: Blower door system used to measure airtightness.

There have been no requirements for a dwelling to meet an airtightness target as is now common in cold-climate countries wanting to minimise energy losses by ensuring that ventilation systems work efficiently. In these countries, airtightness targets are accompanied by passive or active ventilation requirements so there is enough fresh air for contaminant and moisture control.

BRANZ research checks current ventilation and airtightness

BRANZ has been questioning whether homeowners actually open windows enough for ventilation. It has also been measuring airtightness trends in New Zealand homes for several decades.

Previous surveys of New Zealand homes identified a trend towards more airtight construction, despite a lack of Building Code requirements to drive this. Recent measurements as part of the Weathertightness Air quality and Ventilation Engineering (WAVE) programme have shown that this trend has continued in the last two decades.

The latest BRANZ survey measured the airtightness of 60 houses around the country – Auckland, Palmerston North, Wellington and Dunedin – over the last two winters. So far, results for winter 2010 have been analysed, and 2011 results will be available later.

The airtightness of a dwelling is measured with a blower door (see Figure 1). The main component of this is a fan mounted on the frame of an external door that pressurises the house. The resulting airflow through the building envelope at 50 Pa pressure is a measure of the airtightness of the building, often expressed in air changes per hour at 50 Pa (ach@50 Pa). The airtightness expresses how many times the total volume of air contained in the house would go through the fan in 1 hour at a test pressure of 50 Pa. This test pressure is chosen because it is far higher than the normal pressure differences naturally generated by wind and temperature, so the influence on the measurement of these background pressures is reduced. The value of 50 Pa is also that prescribed by international standards (ASTM E779).

From the airtightness measurement, an estimate of the average infiltration rate can be worked out using the air infiltration calculator in ALF (www.branz.co.nz/alf). Infiltration is driven by pressure differences across the envelope generated by wind and temperature differences, which are typically of the order of a few Pa.

Increasing airtightness could impact air quality

There was a marked increase in the airtightness of New Zealand homes from the 1950s to the 1970s, corresponding to a decrease in the number of air changes per hour at 50 Pa (see Figure 2). This was due to the use of aluminium joinery and particleboard floors replacing strip flooring.

The trend continued, although at a slower rate, in the 1980s and early 1990s. The last bar on Figure 2 represents the value obtained in the recent survey for Wellington and Palmerston North houses, indicating the trend is continuing. An airtightness result of 5 ach@50 Pa translates to an estimated average infiltration rate of around 0.25 ach. This means that, in a modern house, about a quarter of the entire volume of air in the dwelling is replaced by fresh air every hour due to air leaking through gaps and cracks.

International guidelines on indoor air quality recommend that the ventilation rate should

ideally be 0.35–0.5 ach. Ventilation should be enough to effectively remove contaminants but not so high as to compromise energy efficiency.

The survey results show that New Zealand homes are becoming sufficiently airtight that infiltration alone will not generally provide adequate ventilation. This could impact indoor air quality and moisture control.

Most houses have sufficient ventilation

However, the infiltration rate is only one component of the ventilation rate in a dwelling. In 15 of the 20 houses monitored, the average ventilation rate was also monitored using a passive tracer gas system. The system comprises small and unobtrusive metal tubes installed in each room of the house and left for a period of 3 or 4 weeks. Dosing tubes continuously release tiny amounts of a safe tracer gas, and sampling tubes absorb the tracer gas. Since ventilation dilutes the tracer gas and we know the release rate from the dosing tubes, the amount of ventilation occurring can be calculated from the amount of tracer absorbed in the samplers.

From the average ventilation rate and average infiltration rate estimated for the 15 houses monitored in 2010, it can be seen that the ventilation rate is usually higher than the infiltration rate by an amount provided either by window opening or mechanical ventilation (see Figure 3).

The data so far shows that ventilation rates around 0.5 ach are achieved, putting most of those houses within the internationally recommended levels of ventilation. Some houses (m, n and o) exhibited higher levels of ventilation due to mechanical ventilation systems.

Some below healthy levels

However, the ventilation in some houses (i and j) was little more than the estimated infiltration rate and below the minimum healthy level.

While analysis of the data collected during winter 2011 is ongoing, a preliminary assessment suggests those measurements will lead to similar conclusions.

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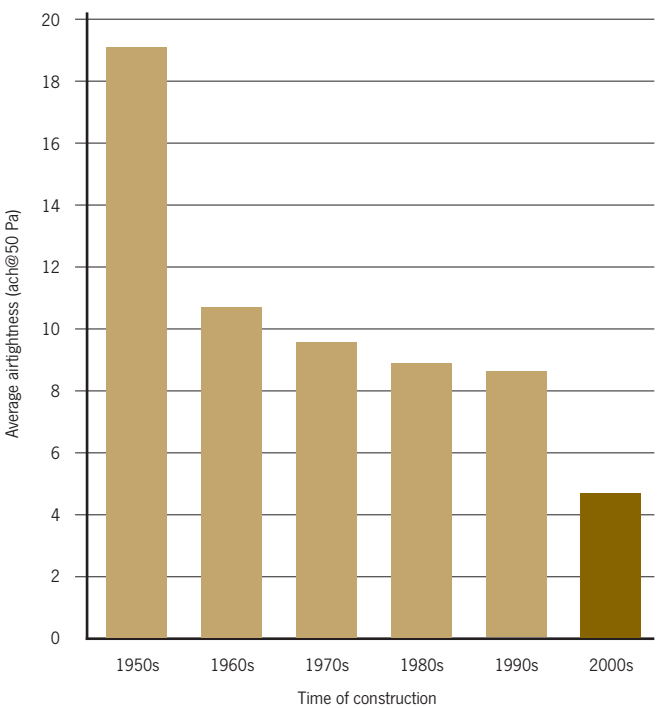

Figure 2: Average airtightness at 50 Pa of New Zealand homes built from the 1950s to the 2000s.

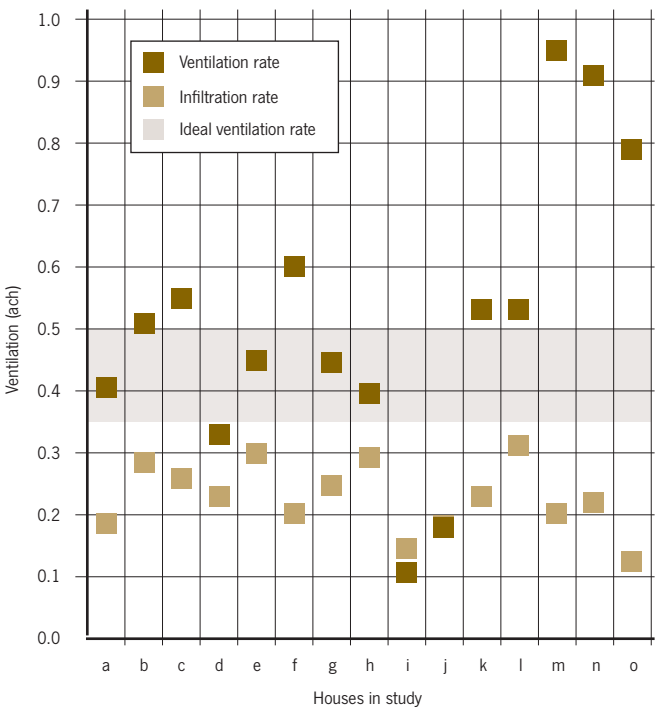

Figure 3: Average ventilation and infiltration rates measured in 15 houses during winter 2010.