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Higher performance from thermal insulation

The range of insulation materials available has grown in recent years. When you're looking for higher performance, what products are available and how do you choose what to specify?

Manufacturers responded to the recently hiked Building Code H1 requirements by introducing products with much higher R-values – up to R7.0 or R8.0 for glass fibre ceiling insulation.

New (or new to Aotearoa New Zealand) products are also available or are being researched made from materials ranging from expanded foams to wood fibre and even hemp. The thermal insulation market is highly competitive.

Bulk insulation materials

- Glass fibre/glass wool – manufactured in Aotearoa and imported, made from up to 80% recycled glass. As noted, it is available in performance levels up to R8.0, which is approximately 330 mm thick or double layer achieving the same performance. Glass fibre has the lowest conductivity of the readily available fibrous insulation materials.
- Polyester – manufactured in Aotearoa and imported. It is a petrochemical material, although some products include fibres made from recycled items such as plastic bottles. Single-layer R-values are mostly up to around R4.0 – higher performance is achieved through double layers. Polyester fibres are likely to be more robust than glass wool.
- Wool and wool blends – made in Aotearoa. Wool blends typically include polyester, although other materials such as hemp are being researched. Single-layer R-values are often lower than those available in glass fibre products, but higher performance can be achieved through double layers.
- Rockwool/mineral wool – not made in Aotearoa or Australia. Products may include post-industrial recycled content. It can have good fire performance depending on the type of binders used.

Seeing double

The practice of using two layers of bulk insulation to enhance thermal performance has been around for many years. For example, the manufacturer of one BRANZ-Appraised polyester ceiling

insulation roll has a double-layer system where two layers of R3.4 give a nominal R6.8 performance – with a nominal total thickness of 280 mm.

Two layers can improve performance, although if the weight of the top layer compresses the layer underneath, the result is likely to be less than double the R-value.

If this approach is taken, the best installation approach is to run the layers at right angles to one another so the edge gaps don't align and to cover the roof joists/truss chords with the top layer with the first layer exactly up to the height of joists/truss chord. The BRANZ *House insulation guide* 6th edition includes the option of a two-layer system.

Rigid foams

The most common forms of rigid foam insulation are expanded (EPS) and extruded (XPS) polystyrene products, often used for insulating under concrete slab-on-ground floors and suspended floors. They commonly have R-values up to around R3.0. Benefits include the fact the EPS doesn't shrink with age.

Other types of rigid foams include PIR (polyisocyanurate – typically with a foil or glass reinforced facing), PUR (polyurethane – sometimes faced) and phenolic (also sometimes faced). These products can give very high performance with R-values of R8.0 or higher with a thickness of approximately half that of an R8.0 glass fibre product.

The drawback of expanded foams is the materials used and the emissions produced. The environmental issues around foam insulation are being closely scrutinised in Europe – for example, the environmental committee of the European Parliament has proposed banning some of the products based on the gases used in production.

Wood fibre

Wood fibre insulation is manufactured in Europe from what would often be waste products. It is available in Aotearoa on special order. The product is generally seen as environmentally friendly because it is made from wood waste and has a far lower petrochemical content than other materials such as expanded foams.

The drawbacks are that it typically has much lower performance than foam products such as PIR (its performance is closer to EPS) and therefore requires more space. It also has transport emissions in getting from Europe to Aotearoa.

Cost, availability of product and preferred method of installation are parts of the decision on what material to use.

Embodied emissions

Greenhouse gas emissions should be a consideration in all construction material purchases. Installing insulation materials that give high performance can reduce the operational greenhouse gas emissions of a home because it requires less heating energy, but what about the emissions from the manufacture of the insulation? Some products have embodied emissions that are 10 times higher (per kg of material) than others. The data for embodied emissions can be found in some manufacturers' environmental product declarations. Data from these documents is included in the CO_2NSTRUCT tool.

The BRANZ tool CO_2NSTRUCT lets you see what proportion of renewable energy was used in manufacture. For example, while some imported glass fibre products have almost the same total embodied energy as Aotearoa-made products, the local products have the advantage that their manufacture uses a much higher proportion of renewable energy (see www.branz.co.nz/environment-zero-carbon-research/framework/branz-co2nstruct/).

Consideration of emissions should include how far the material has travelled. Products manufactured in Prague will have higher transport emissions than products made in Penrose.

Selection issues

BRANZ Building Physicist Ian Cox-Smith says cost, availability of product and preferred method of installation are other parts of the decision on what material to use.

'A dense insulation product with a particular R-value will generally cost more than a lower-density, thicker product with the same R-value,' he says. In terms of sustainability, 'it is generally a balancing act. A high-performance, lower-conductivity material may not be as good in other areas.'

Good installation crucial for performance

Whatever product of whatever R-value is selected, good installation is crucial to maximising its performance:

- Keep the material completely dry before, during and after installation. Moisture reduces the R-value of insulation. A product that is soaking wet should be replaced.
- Avoid gaps and folds. BRANZ testing has found that a 16 mm gap around the edge of ceiling insulation can cut its R-value by almost half, and a 100 mm R2.0 fibre product compressed to 80 mm can have its R-value reduced to R1.6.
- Avoid gaps in ceiling insulation by avoiding penetrations in ceilings as much as possible.
- With ceiling insulation using a single layer, ensure the insulation closes together over the roof joists. Some bulk insulation products require notching to achieve this, others don't.
- When installing insulation between floor joists under a suspended floor, fit it tightly against the underside of the flooring to prevent any underfloor air movement.

FOR MORE If you haven't already, download the free standard NZS 4246:2016 *Energy efficiency – Installing bulk thermal insulation in residential buildings*, which is referenced in H1/AS1 at www.standards.govt.nz/shop/nzs-42462016