sustainable energy›INFO

›INFO fact sheet

INSULATION BENEFITS

The contents of this fact sheet outline the benefits of insulation, how insulation performance is measured and types of insulation products. Guidelines are provided for insulation selection and installation.

Insulation is the most effective way to improve the energy efficiency of a home. Insulation of the building envelope helps keep heat in during the winter, but lets heat out during summer to improve comfort and save energy.

Insulating a home can save 45–55% of heating and cooling energy. Table 7.1 shows the savings on heating and cooling energy when insulation is installed.

EXTENT OF INSULATION	HEATING	COOLING	HEATING AND COOLING
Ceiling only (added R2.5)	15–25%	30–45%	20–30%
Ceiling (added R2.5) and walls (added R1.0)	40–50%	40–55%	40–50%
Ceiling (added R2.5), walls (added R1.0) and floor (added R1.0)	45–55%	35–50%	45–55%

Table 7.1: Typical energy savings due to insulation

Benefits of insulation:

> comfort is improved year-round;

> it reduces the cost of heating and cooling by over 40%;

> it pays for itself in around five to six years;

> there is less need for heating and cooling which saves non-renewable resources and reduces greenhouse gas emissions;

> it virtually eliminates condensation on walls and ceilings; and

> some insulation materials can also be used for sound proofing.

How insulation works

An uninsulated home is subject to considerable winter heat losses and summer heat gains (see figure 7.1).

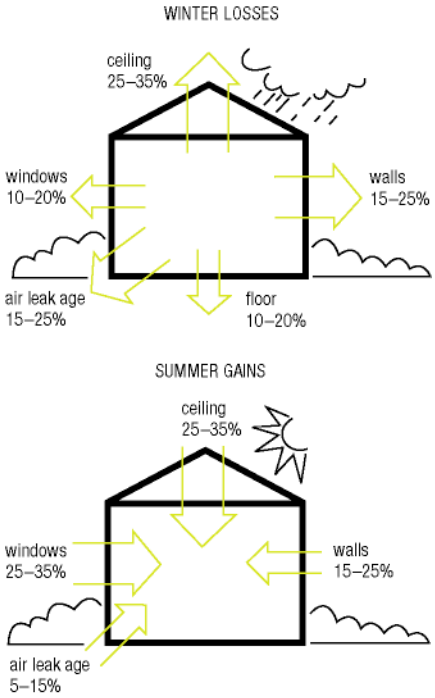

Figure 7.1: Heat flow without insulation

All materials allow a measure of heat to pass through them. Some, such as metal, glass or air, allow heat to pass through more easily. Others, including animal fur or wool, thick clothing and still air, are much more resistant to heat flow, and are referred to as insulators.

The term ‘insulation’ refers to materials which provide substantial resistance to heat flow. When these materials are installed in the ceiling, walls, and floors of a building, heat flow into and out of the building is reduced, and the need for heating and cooling is minimised.

Although ceilings and walls may be insulated, heat loss will still occur in winter if there are large areas of unprotected glass or through fixed wall vents and gaps and cracks around external doors and windows. Appropriate internal window coverings (e.g. lined drapes with pelmets) and draught proofing are vital to complement insulation.

Insulation should always be coupled with appropriate shading of windows and adequate ventilation in summer. Without shading, heat entering the home through the windows will be trapped inside by the insulation and cause discomfort.

Understanding heat transfer

There are three ways in which heat is transferred—radiation, convection and conduction.

A warm plasterboard ceiling in winter provides an example of these different methods of heat transfer.

Radiation

Radiation is the direct heat which can be sensed by the skin, such as the sun's rays or the heat from an open fire. Heat (infra-red) radiation which is emitted from the surface of hot objects, travels in straight lines to cooler objects. With radiant heat transfer, heat is emitted from the warm plasterboard ceiling to cooler roof tiles on a cold night (see figure 7.2).

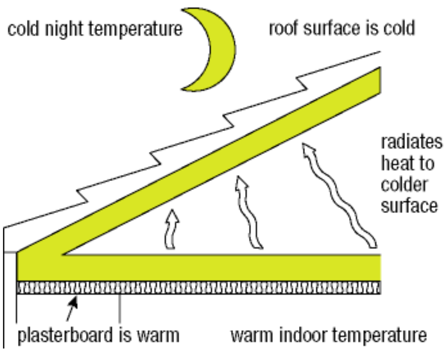

Figure 7.2: Radiant heat transfer

Convection

Convection transfers heat through the movement of gases or liquids. For instance, when air is warmed, it rises and is replaced by cooler air. This creates a cycle or convection current capable of transferring heat. With convective heat transfer, the warm layer of air above the ceiling rises and comes into contact with the cold roof surface, cools by losing some heat to the roof material, then falls to the plasterboard where the process repeats itself (see figure 7.3).

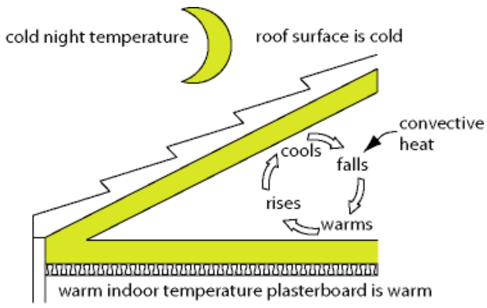

Figure 7.3: Convective heat transfer

Conduction

Conduction is heat transfer from warm to cooler areas within a material, or between two materials touching each other. Gases, such as air, do not conduct heat very well. Solids, particularly metal, conduct heat much more readily. With conductive heat transfer, heat inside the home warms the bottom layer of plasterboard ceiling which transfers heat to the next layer, and so on (see figure 7.4).

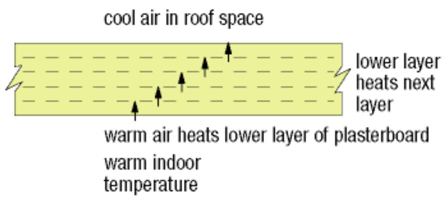

Figure 7.4: Conducted heat transfer

Principles of insulation

Resistance to heat flow is achieved by the use of either bulk insulation or reflective insulation, which work in different ways.

Bulk insulation

Bulk insulation traps millions of tiny pockets of still air or other gases within its structure. These air pockets provide the resistance to heat flow. Bulk insulation reduces radiant, convective and conducted heat flow (see figure 7.5).

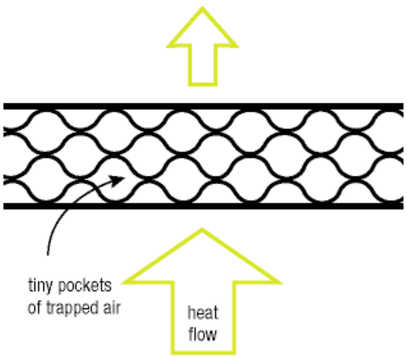

Figure 7.5: Bulk insulation and heat flow

Reflective insulation

Reflective insulation works by reducing the radiant heat transfer across an enclosed space, e.g. between bricks and plasterboard in an insulated brick veneer wall. Reflective foil in walls or under the roof reflects radiant heat away from the interior in summer. It works most effectively in conjunction with a still air layer (enclosed air space) of at least 25 mm (see figure 7.6). Reflective insulation needs to remain clean and dust-free for best performance.

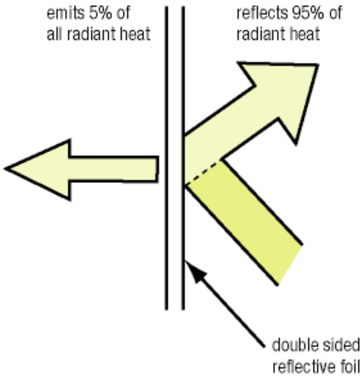

Figure 7.6: Reflective insulation and heat flow

How insulation performance is measured

R value

All insulation materials are rated for their performance in restricting heat transfer. This is expressed as the R value, also known as thermal resistance or resistivity. The R value is a guide to its performance as an insulator—the higher the R value, the greater the insulating effect.

R values are expressed using the metric units m^2/K/W, where:

> m^2 refers to one metre squared of the material of a specified thickness;

> K refers to a one degree temperature difference (Kelvin or Celsius) across the material; and

> W refers to the amount of heat flow across the material in watts.

Products which have the same R value will provide exactly the same insulating effect as each other, provided they are correctly installed.

If manufacturers' information is not available, R values can be calculated using the data and methods contained in the following:

> Australian Standard *AS2627.1 (1993): Thermal insulation of dwellings*

> *The Australian Institute of Refrigeration, Air Conditioning and Heating handbook*

U Value

Sometimes insulation is rated in terms of its U value, rather than its R value. The U value measures the transfer of heat through a material or a building element (thermal transmittance), whereas the R value measures the resistance to heat transfer. U values are often used in technical literature, especially to indicate the thermal properties of glass and to calculate heat losses and gains. The U value is the reciprocal of the R value, R=1/U or U=1/R. For example, with an R value of 2.0, the U value is 1/2 or 0.5.

The U value is expressed using the metric units ($W/m^2/K$) where:

> W refers to the amount of heat transmitted across the material in watts;

> m^2 refers to one metre squared of the material of a specified thickness; and

> K or 'degree Kelvin' refers to each °C temperature difference across the material.

Worked example

An insulated brick veneer wall with an overall R value of 1.7 has a U value of 0.588 W/m^2 (i.e. one divided by 1.7). This means that 0.588 W of heat will be transferred through each m^2 of wall if there is a one degree difference between the inside and outside temperatures (see figure 7.7).

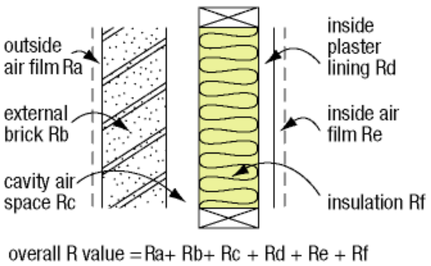

Figure 7.7: Overall R value of brick veneer wall