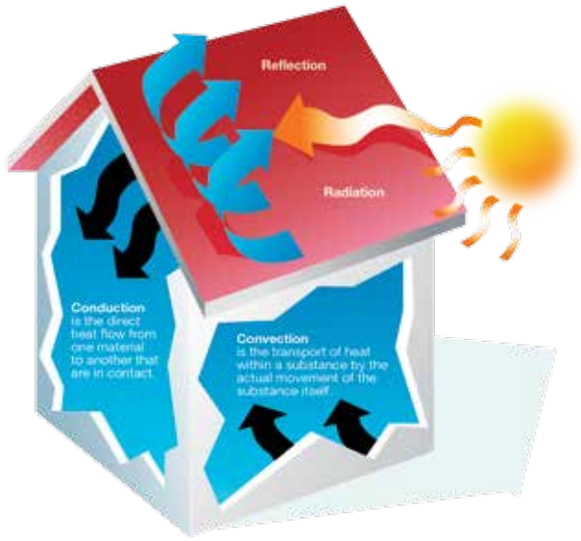
Performance Characteristic of Glass

Heat Flow

Heat flows through glazed elements such as a windows, glass doors or fixed glass panels is determined by the combined effect of the glass, frame and seals.

Heat flows through glazed systems in several ways:

1. Conduction
2. Convection
3. Radiation



01 Conduction

Conduction is the movement of heat energy through the glass and frame materials from the air on the warmest side to the air on the colder side. The greater the difference in temperatures – the more heat flow. Different frame and glass materials have varying ability to conduct heat, specified by the U-value. The lower the U-value, the less heat is transmitted.

There is a simple formula that can help you quantify the impact of improved U-value:

U x T x A = watts

- the amount of heat conducted through a glazed unit (in Watts) equals the U-value (U)
- multiplied by the number of degrees difference in air temperature on each side (T)
- multiplied by the area of the glazing unit (A)

How Low U-value helps save energy?

If a building has 45m^2 of windows and glazed door with aluminium frames, on sunny day when it is 10° hotter outside, the heat gain would be about:

6.0 x 10 x 45 = 2700 watts

That's almost equivalent to the total heat output of 1hp air conditioner running at full capacity (9000 btu/hr).

If you roughly halve the U-value of the window by selecting double glazing, you can halve the heat gain – in this example saving about 1350 watts of heat gain – equivalent to the energy use of twenty three unit of 60 watt incandescent light bulbs.

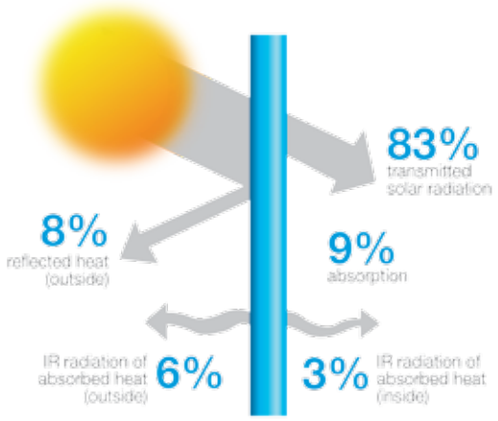
02 Convection

Convection is define as the movement of heat energy by air that passes over the surface of the glazing unit, taking heat away from the glass and frame. Higher air speed causes greater convection heat transfer. Minimising convective heat transfer can be achieved by reducing air movement adjacent to the surfaces of glazing units through shielding the exterior by walls, screens and plantings and by shielding the interior with curtains and pelmets. It can also be achieved through double glazing which creates a still gas layer between the panes.

03 Radiation

Solar radiation is heat that is transmitted as electromagnetic waves. They can pass through space, in the same way as visible light moves through space, until reflected or absorbed by materials.

The sun transmits solar radiation which is comprised of ultraviolet (2% of the total solar energy), visible (47%) and solar near-infrared (IR) (51%). Warm objects like people and buildings, radiate the longer wavelengths of infrared heat. When sunlight strikes a sheet of glass, some of the solar radiation is transmitted straight through, some is reflected and some is absorbed by the glass. The heat energy absorbed by the glass is then radiated to both the inside and outside as infrared radiation. The sum of reflected, absorbed and transmitted heat always equals 100%.



For example, 3mm clear glass: 83% of solar radiation is transmitted, 8% reflected and 9% is absorbed. 3% is then radiated inside and 6% outside.

The total amount of solar heat that passes through the glass is the sum of the heat transmitted plus that part of the heat absorbed in the glass which is subsequently re-radiated and convected inside. For the above example this equals 86%. This proportion of solar energy that passes through the window, both directly and indirectly, is called the Solar Heat Gain Coefficient (SHGC). Therefore, 3mm clear glass has a SHGC of 0.86.

The amount of infrared heat energy radiated from the surface of glass depends on its emissivity (also known as emittance). A 'perfect radiator' has an emissivity of 1.0. Untreated (uncoated) glass, whether clear or tinted, has an emissivity of 0.84. It is almost a perfect radiator. Low emissivity (low-e) glass has a coating on its surface which minimises the amount of heat, absorbed by the glass, being subsequently radiated into the building. It can also be designed to block some of the solar radiation transmitted through glass. Low-e glass is available with an emissivity as low as 0.03.

Double glazing is an effective way to reduce U-value, but its impact on solar heat gain depends on the type of glass. One layer of clear glass has a SHGC of 0.86. Two layers have a combined SHGC of about 0.76.