Insulation values: units of measurement and relationship between parameters

Thermal Resistance

R-value is a measure of apparent thermal conductivity, and thus describes the rate that heat energy is transferred through a material or assembly, regardless of its original source.

The SI unit for R-value is kelvin square meters per watt ($K \cdot m^2/W$).

The imperial unit for R-value is degree Fahrenheit square feet hours per Btu, ($ft^2 \cdot °F \cdot h/Btu$). The conversion factor is 1 $ft^2 \cdot °F \cdot h/Btu \approx 0.1761\ K \cdot m^2/W$, or 1 $K \cdot m^2/W \approx 5.67446\ ft^2 \cdot °F \cdot h/Btu$. Sometimes the nomenclature *RSI* is used to denote the SI form of the value. In contrast, the imperial unit is often written as *R–##* where the *##* is the R-value. To complicate matters, some countries that employ the SI system (e.g. New Zealand) retain the *R* (in lieu of RSI) but incorporate a dash e.g. *R–5.53*.

Thermal conductance

The U-value is the opposite of the R-value and indicates the conductance of heat.

Thermal Resistivity

Thermal Resistivity is the opposite of the λ-value and is the property of a material that indicates its resistance to heat conduction

Thermal conductivity

In physics, thermal conductivity, *k*, is the property of a material that indicates its ability to conduct heat.

The SI unit for k-value is watt per kelvin meter (W/K.m)

In Europe, the k-value of construction materials (e.g. window glass) is called λ-value.

K-value

The K-value(with capital k) refers in Europe to the total isolation value of a building. K-value is obtained by multiplying the *form factor* of the building (= the total inward surface of the outward walls of the building divided by the total volume of the building) with the average U- value of the outward walls of the building. K-value is therefore expressed as $(m^2.m^{-3}).(W.K^{-1}.m^{-2}) = W.K^{-1}.m^{-3}$. A house with a volume of 400 m^3 and a K-value of 0.45 (the new European norm. It is commonly referred to as K45) will therefore theoretically require 180 W to maintain its interior temperature 1 degree K above exterior temperature. So, to maintain the house at 20°C when it is freezing outside (0°C), 3600 W of continuous heating is required.

Thermal Resistance (R) gives you an idea of the resistance to heat loss per m^2. For example, if the interior of your home is at 20 °C, and the roof cavity is at 10 °C, the temperature difference is 10 K. Assuming a ceiling insulated to R–2, energy will be lost at a rate of 10 K / 2 $K \cdot m^2/W$ = 5 watts for every square metre of ceiling.
It is reasonable to sum the R-values of bulk insulators e.g., $R\text{-value}_{(brick)} + R\text{-value}_{(fibreglass\ batt)} + R\text{-value}_{(plasterboard)} = R\ value_{(total)}$.

The relation between the λ-value and the R value is: R = thickness/ λ