

R-Values Explained

R-value is expressed as rate of heat loss per hour per square foot per inch of thickness of material per degree Fahrenheit. R-values can be expressed in metric units (SI units) as well as Imperial (or Inch-Pound) units. The metric thermal resistance is sometimes referred to as the "RSI value." The R-value in I-P units per inch is obtained from the RSI value by multiplying the RSI value by 5.678 / (W/m K) and then by 0.0254 meters/inch to obtain the R-value per inch.



Figure 1: Two inches of XPS insulates as well as 30 inches of snow.

As an example, the thermal conductivity of ice (at -1°C is $2.24 \text{ W}/(\text{m}\cdot\text{K})$. The RSI value of thermal resistance is $(1 / 2.24) = 0.446$. R-value per inch in I-P units equals 5.678 times $(0.0254 \text{ meters}/\text{inch})$ times $0.446 \text{ RSI} = 0.06$.

Material	Thermal Conductivity (W/m·K)	Thermal Resistance, R-value for 1 in. thickness ($\text{ft}^2 \text{ }^{\circ}\text{Fh}/\text{BTU}$)
XPS	0.029	5.0
fresh snow	0.19	0.76
compact snow	0.43	0.34
ice -1°C	2.24	0.06
ice -20°C	2.45	0.06
water 20°C	0.6	0.24
soil dry	0.8	0.18
soil damp	2	0.07
still air	1.2	0.12
concrete	1.4	0.10
concrete	2.6	0.06
wood	0.115	1.25

Table 1: Values of thermal conductivity and R-value per inch for select materials. Values adapted from John Straube, "High Performance Building Enclosures," Building Science Press, 2012, Appendix A.

References

<https://www.buildingscience.com/bookstore/books/high-performance-enclosures>

<https://www.amazon.com/High-Performance-Enclosures-John-Straube/dp/0983795398>