R VALUES FOR STILL AND CONVECTIVE AIR

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Reference: Daniel V. Schroeder, *An Introduction to Thermal Physics*, (Addison-Wesley, 2000) - Problem 1.58.

The R value of a material is a measure of its effectiveness as a thermal insulator, and is calculated from its thickness Δx and thermal conductivity k_t:

$$R = \frac{\Delta x}{k_t} \tag{1}$$

As an example, we can compare the R values of a layer of air with that of a layer of fibreglass insulation. The values given in Schroeder (converted to sensible SI units) are, for a layer of thickness 0.0889 m (3.5 inches):

$$R_{air} = 0.176 \text{ k m}^2\text{W}^{-1} \tag{2}$$

$$R_{fibre} = 1.92 \text{ k m}^2\text{W}^{-1} \tag{3}$$

The R_{air} value here includes the effects of convection (that is, the air has currents in it so it's not still). For still air, the thermal conductivity is $k_t = 0.026$ so

$$R_{still} = \frac{0.0889}{0.026} = 3.42 \text{ k m}^2\text{W}^{-1} \tag{4}$$

That is, still air is actually almost twice as good an insulator as fibreglass. The R_{air} value above is for a vertical layer of air, in which we could expect the effects of convection to be fairly substantial, given that the temperature tends to vary with height above the ground, which would set up air currents.