1-1. Summary

Convective heat transfer

Heat is transmitted from one object to another by various ways such as conductivity, convection, radiation. One of the main ways of transferring heat is convection . In the convection method, a part of the material that is heated moves upwards and replaces parts that have not yet been heated. This way the heat energy is transferred from one point to another and gradually all the material is heated.

The convective flow is due to the density of matter. We know that when a material heats up, it expands, so that the molecules are spaced apart. As a result, its density decreases. That is why when we heat a portion of a liquid, the density of that liquid decreases and that portion moves upwards. For transferring convective flow, the substance must be liquid or gas and there should be temperature difference between the two points.

1-2. Question

Glass is made of sand and other minerals that are melted together at very high temperatures to form a material that is ideal for a wide range of uses. Since it is an amorphous solid material, it has not high thermal conductivity. So increasing the thickness of the glass will not have a notable effect on total resistance.

2. Mistakes

I had two mistakes on calculating the total resistance.

3-1. solving problem

$$R_{total} = 2 \times R_g + R_{conv1} + R_{conv2} + R_{AIR\ GAP}$$

$$Rg_1 = Rg_2 = \frac{L}{(0.78 \times 1.2)} = \frac{0.006}{0.936} = 0.0064 \ °C/W$$

$$R_{AIR\ GAP} = \frac{L}{k_{air\ gap} \times A} = \frac{0.013}{0.026 \times 1.2} = 0.416 \ °C/W$$

$$R_{conv1} = \frac{1}{h_1 \times A} = \frac{1}{10 \times 1.2} = 0.0833 \ °C/W$$

$$R_{conv2} = \frac{1}{h_2 \times A} = \frac{1}{40 \times 1.2} = 0.020 \ °C/W$$

$$R_{total} = 56.380 \ °C/W$$

$$\dot{Q} = \frac{T_{\infty 1} - T_1}{R_{conv\ 1}}$$

$$T_1 = T_{\infty 1} - (\dot{Q} \times R_{conv\ 1})$$

$$T_1 = 20 - \left(56.23 \times \frac{1}{10 \times (0.8 \times 1.5)}\right)$$

$$T_1 \approx 15.3 \ °C$$

3-2. Comment

The air gap is too narrow to allow the air to circulate easily. This therefore reduces the rate of heat transfer by convection. The trapped air reduces the rate of heat loss through the window by convection.