• Summary about the convective heat transfer

convective heat transfer, also called heat convection happens between two moving fluids (liquid and gas, liquid and liquid and gas, etc)

two types of convection:
natural and forced

~~Thermal resistance.~~

• Natural convection happens when two moving fluid or a solid and a moving fluid with different temperature contact without external force, the heat is transferred from the hotter part to the cooler part

• Forced convection happens when the two moving fluid or a solid with different temperature contact due to external force, the heat is transfereed from the hotter part to the cooler part.

Thermal resistance:
thermal resistance, also call heat resistance is defined as the difficulty of heat in passing through a solid, liquid or gaseous medium. It is represented in R and the unit is K/W or °C/W

Question:

Why increasing the thickness of a single pane glass does not increase the total resistance?

Answer:

Since the thermal resistance of glass is a quite small value ~~for the~~ by 0.0043°C for the total thermal resistance ~~for~~ by 0.4332°C/W in that case. Therefore, it's not possible for significantly increasing the total thermal resistance by increasing the glass's.

Review of the mistakes:

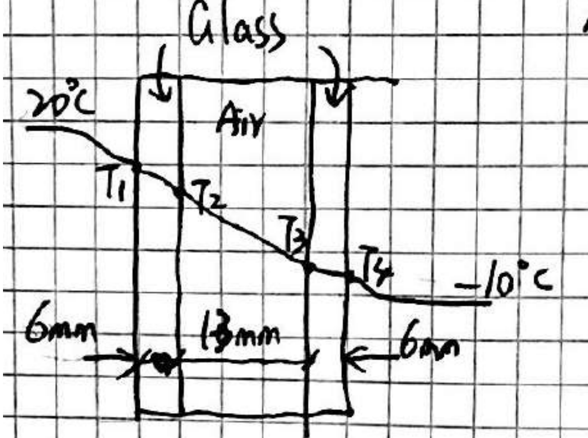
Neglected the different units for meters and milimeters

Application:

Consider a 0.8m-high and 1.5m-wide double-pane window consisting of two 6-mm-thick layers of glass ($k = 0.78\ W/m°C$ separated by a 13-mm-thick stagnant air space ($k = 0.026\ W/m°C$).

~~Determine the steady rate of heat transfer coefficients on the inner and outer surfaces of the window to~~

Determine the steady rate of heat transfer through this double pane window and the temperature of its inner surface. (Take the convection heat transfer coefficients on the inner and outer surfaces of the window to be $h_1 = 10\ W/m^2 \cdot °C$ and $h_2 = 40\ W/m^2 \cdot °C$, which includes the effect of radiation.



Answer:

The area of surface is:

$$A_{glass} = 0.8 * 1.5 = 1.2\ m^2$$

The thermal resistance of convection between inner surface and air:

$$R_{conv,1} = \frac{1}{h_1 A} = \frac{1}{10 * 1.2} \approx 0.0833\ °C/W$$

The thermal resistance of convection between outer surface and air:

$$R_{conv,2} = \frac{1}{h_2 A} = \frac{1}{40 * 1.2} \approx 0.0208\ °C/W$$

The thermal resistance of convection ~~between~~ of a 6-mm-thick glass:

$$R_{glass} = \frac{L}{kA} = \frac{0.006}{0.78 * 1.2} \approx 0.0064\ °C/W$$

The thermal resistance of convection of a 13-mm-thick air space

$$R_{air} = \frac{L}{kA} = \frac{0.013}{0.026 * 1.2} \approx 0.4167\ °C/W$$

Total thermal resistance of the window is:

$$R_{total} = R_{conv,1} + R_{conv,2} + 2 * R_{glass} + R_{air}$$

$$= 0.0833 + 0.0208 + 2 * 0.0064 + 0.4167$$

$$= 0.5336\ °C/W$$

the steady rate of heat transfer through this double-plane window:

$$\dot{Q} = \frac{T_{\infty 1} - T_{\infty 2}}{R_{total}} = \frac{20-(-10)}{0.5336} \approx 56.2W$$

$$\dot{Q} = \frac{T_{\infty 1} - T_1}{R_{conv,1}} \rightarrow 56.2 = \frac{20 - T_1}{0.0833} \rightarrow T_1 = 20 - 56 * 0.0833$$

$$T_1 = 15.3°C$$