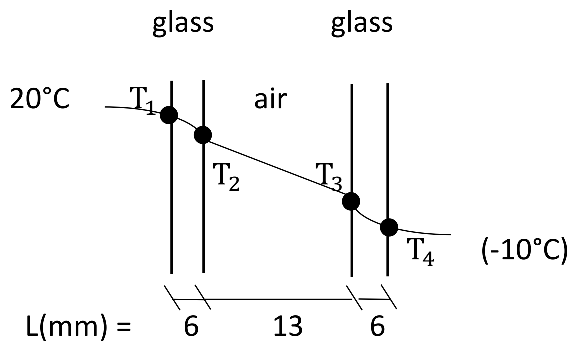
WEEK 2 _ POJER ILARIA

EXERCISE 2

Consider a 0,8 m high and 1,5 m wide double pane window, shown above with a thermal conductivity k = 0,78 W/m°C, k_{air} = 0,026 W/m°C. Determine the steady rate of heat transfer through this glass window and the temperature of the inner surface.



h_1= 10 W/m^2 °C

h_2= 40 W/m^2 °C

A =1,2 m^2

$$R_{total} = \frac{1}{A\,h_1} + \frac{L_1}{k_1\,A} * 2 + \frac{L_2}{k_2\,A} + \frac{1}{A\,h_2} = \frac{1}{12} + \frac{0{,}006}{0{,}78*1{,}2} *2 + \frac{0{,}013}{0{,}026*1{,}2}\ \frac{1}{40*1{,}2} =$$

= 0,08333 + 0,01282 + 0,41666 + 0,02083 = 0,5336 °C/W

$$\dot{Q} = \frac{T_{\infty 1}-T_{\infty 2}}{R_{total}} = \frac{20-(-10)}{0{,}5336} = 56{,}222 \text{ W}$$

$$\dot{Q} = \frac{T_{\infty 1}-T_{s2}}{R_{conv1}} \longrightarrow 56{,}222 = \frac{20-T_1}{0{,}0833} \Rightarrow T_{s1} = 15{,}3\ °C$$

SUMMARY of 2nd LECTURE (9 october)

Convective heat transfer

Rate of convection heat transfer depends on:

- Temperature difference
- Velocity of liquid or gas
- Kind of liquid or gas

Convection Newton’s law of cooling

$\dot{Q}$conv = hA_s (T_s-T_∞)

$\dot{Q}$conv = $\frac{T_s-T_\infty}{R_{conv}}$ [W]

R_{conv} = $\frac{1}{hA_s}$ [°C/W] (resistance)

T_s = temperature on the surface

T_∞ = omogeneus temperature of the wall

h = convection heat transfer coefficient

when h $\rightarrow \infty \Rightarrow R_{conv}$ = 0 and $T_s \approx$ T

$\frac{\Delta T}{R_{electrical}}$ electrical resistance

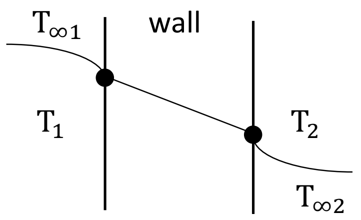
The surface offers no resistance to convection.
What does you usually know when you want to know $\dot{Q}$conv of wall?

- Materil
- T of air
- Thickness of wall

Inside the wall tere is conduction
When temperature flows in the wall there is convection
When temperature out of the wall there is convection

Thermal resistance network

$\dot{Q} = \frac{T_{\infty 1} - T_{\infty 2}}{R_{total}}$ [W]



h doesn't depend on srface material but on how fast is the flow

$T_{\infty 1}$ is inside

$T_{\infty 2} \approx 0$

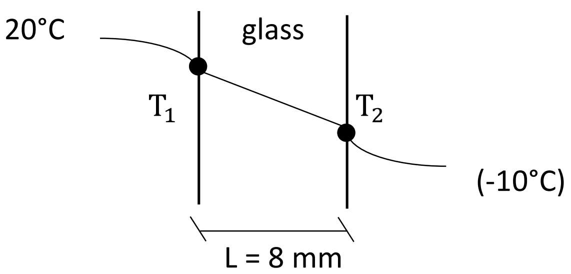
k is the conductivity material coefficient

Heat loss through a single pane window

Consider a 0,8 m high and 1,5 m wide glass window, shown above with a thermal conductivity k = 0,78 W/m°C. Determine the steady rate of heat transfer through this glass window and the temperature of the inner surface.

h_1= 10 W/m^2 °C

h_2= 40 W/m^2 °C



$R_{total} = \frac{1}{A\,h_1} + \frac{L}{k\,A} + \frac{1}{A\,h_2} = \frac{1}{0,8*1,5*10} + \frac{0,008}{0,78*A} + \frac{1}{40*A}$ = 0,11271 °C/W

R_g = 0,0085 °C/W

R_{conv1} = 0,0833 °C/W

R_{conv2} = 0,0208 °C/W

$\dot{Q} = \frac{T_{\infty1}-T_{\infty2}}{R_{total}} = \frac{20-(-10)}{0,1126}$ = 266,4298 W it's the power, heat flux

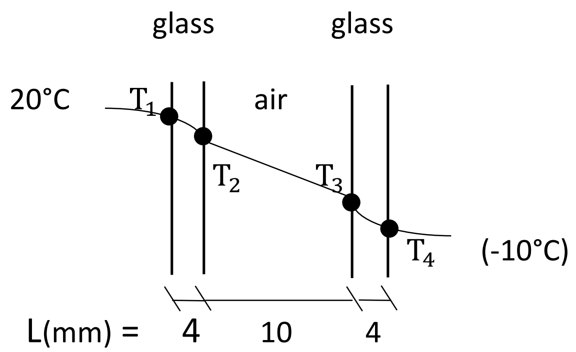
<u>Conclusion</u>: R_g is lower than R_{conv1} and R_{conv2}, so inside the wall the resistance is lower than on the surfaces.
The higher resistance is on the indoor surface.
The resistence of the glass is consistently lower thanthe convection resistance.
If you propose to incerase R_g increasing the thickness is useless, the glass doesn't have effect on heat transfer.
So you must introduce air between two glasses.
Minimum value because of mechanical stability is 8 mm thickness for glass, o avoid that it breaks.

Heat loss through a double pane window

Consider a 0,8 m high and 1,5 m wide double pane window, shown above with a thermal conductivity k = 0,78 W/m°C, k_{air} = 0,026 W/m°C. Determine the steady rate of heat transfer through this glass window and the temperature of the inner surface.

h_1= 10 W/m^2 °C

h_2= 40 W/m^2 °C



A =1,2 m^2

$R_{total} = \frac{1}{A\,h_1} + \frac{L_1}{k_1\,A} * 2 + \frac{L_2}{k_2\,A} + \frac{1}{A\,h_2} = \frac{1}{12} + \frac{0,004}{0,78*1,2} *2 + \frac{0,01}{0,026*1,2}\ \frac{1}{40*1,2}$ = 0,4332 °C/W

$\dot{Q} = \frac{T_{\infty1}-T_{\infty2}}{R_{total}} = \frac{20-(-10)}{0,4332}$ = 69,252 W

$\dot{Q} = \frac{T_{\infty1}-T_{S2}}{R_{conv1}} \rightarrow 69,252 = \frac{20-T_1}{0,0833} \Rightarrow T_{s1}$ = 14,2 °C