Weekly submission 2 (Week2_AiutiFrancesca) 16/10/19

1. Write a summary about convective heat transfer (a) and explain (b) why increasing the thickness of a single pane glass does not increase the total resistance.
Explain the mistakes that you might have done in class.

(TES → Propositories → Fork)

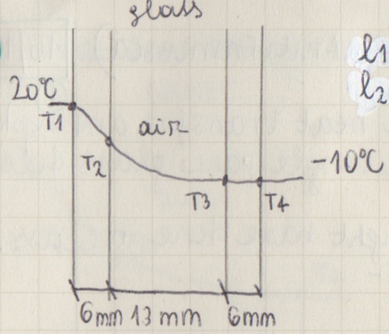
2. Solve a problem with the same panel window with the air gap thickness of 13 mm and glass thickness of 6 mm.
Comment on your results and explain why we have an optimal range for the air-gap's distance.

1. a) Convective heat transfer (convection) is the transfer of heat from one place to another by the movement of fluids.
There are two typologies of convection: natural convection and forced convection.
Convection-cooling can be assumed to be described by Newton's law of cooling: the rate of heat loss of a body is proportional to the difference in temperatures between the body and its surroundings while under the effects of a breeze. The constant of proportionality is the heat transfer coefficient.
The basic relationship for heat transfer by convection is:

$$\dot{Q} = hA_s(T_s - T_\infty).$$

b) If we increase the thickness of a single pane glass the result is completely useless, since it does not have effect on heat transfer. The solution is to introduce air, increasing glass thickness but with a gap inside the two panes.
This happens because the resistance of the glass is consistently lower than the convection resistance. The higher resistance is located in the indoor surface.

2



$l_1 = 0{,}006\,m$ $h_1 = 10\,W/m^2C$ $h = 0{,}8\,m$

$l_2 = 0{,}013\,m$ $h_2 = 40\,W/m^2C$ $l = 1{,}5\,m$

$A = 1{,}2\,m^2$ $k_1 = 0{,}78\,W/mC$

$k_2 = 0{,}026\,W/mC$

$$R_{TOT} = \frac{1}{h_1 A} + \frac{L_1}{K_1 A} + \frac{L_2}{K_2 A} + \frac{L_1}{K_1 A} + \frac{1}{h_2 A} = \frac{1}{10\,\frac{W}{\cancel{m^2}C} \cdot 1{,}2\,\cancel{m^2}} + \frac{0{,}006\,\cancel{m}}{0{,}78\,\frac{W}{\cancel{m}C} \cdot 1{,}2\,\cancel{m^2}} +$$

$$+ \frac{0{,}013\,\cancel{m}}{0{,}026\,\frac{W}{\cancel{m}C} \cdot 1{,}2\,\cancel{m^2}} + \frac{0{,}006\,\cancel{m}}{0{,}78\,\frac{W}{\cancel{m}C} \cdot 1{,}2\,\cancel{m^2}} + \frac{1}{40\,\frac{W}{\cancel{m^2}C} \cdot 1{,}2\,\cancel{m^2}} =$$

$$= 0{,}0833\,C/W + 0{,}0056\,C/W + 0{,}4167\,C/W + 0{,}0056\,C/W + 0{,}0208\,C/W$$

$$0{,}532\,C/W$$

$$\dot{Q} = \frac{T_{\infty 1} - T_{\infty 2}}{R_{TOT}} = \frac{(20 - (-10\,\cancel{°C}))}{0{,}532\,\cancel{C}/W} = \frac{30}{0{,}532}\,W = 56{,}39\,W$$

⇒ It is possible to see that if in the glass pane we increase the air gap and the thickness of the panels, the total resistance increases, but the power of the air flux inside the gap decreases.