submission week **2**

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1 Write a short summary about the convective heat transfer and explain why increasing the thickness of a single pane glass does not increase the total resistance.

Convective heat transfer takes place when a solid is in contact with a different temperature fluid.

Due to the temperature difference there is a heat flow between the surface of the body and the particles of the fluid in contact whit it which causes a **change in the density** of the fluid layers near the surface.

The density difference makes the lighter fluid move upwards and the heavier one down.

Generally it happens that a gas at temperature T_1 moving gets in contact with a surface whose temperature is T_s and goes away to the temperature T_2 different from T_2.

Conductive heat transfer can be expressed with **Newton's Law**:

$$\dot{Q}_{conv} = hA_s\,(T_s - T_\infty) \qquad (W)$$

There are two different types of convection:

- ► **natural convection**: when fluid movement is caused only by density differences;
- ► **forced convection**: when the fluid movement is generated by external agents such as fans or pumps.

Conclusions

The rate of convective heat transfer depends on:

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

→ In case of heat loss through a window increasing the thickness of a single pane glass doesn't increase the total resistance because the thermal conductivity coefficient of the glass (K) is very large (it is a non-insulating material) then its convection resistance is very low (almost 0). The surface doesn't offer resistance to convection and therefore doesn't slow down the heat transfer process, then condensation occurs on the surface.

2 Write an explanation about what mistakes you made in the class that resulted in wrong answers.

In exercise B done in class my result was wrong because I failed to calculate the equivalence from millimeters to meters.

8mm = 0.008m ✓ 8mm = 0.08m ✗

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

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/m²·°C and h_2= 40 W/m²·°C (which includes the effects of radiation).

Commment on your results and explain why we have an optimal range for the air-gap's distance.

$A = 0.8 * 1.5 = 1.2 \text{ m}^2$

$$R_{g_1} = R_{g_2} = \frac{L_g}{\left(K_g \times A\right)} = \frac{0.006}{0.78 * 1.2} = 0.0064\ °C/W$$

$$R_{airGap} = \frac{L_{airGap}}{\left(K_{airGap} \times A\right)} = \frac{0.013}{0.026 * 1.2} = 0.4167\ °C/W$$

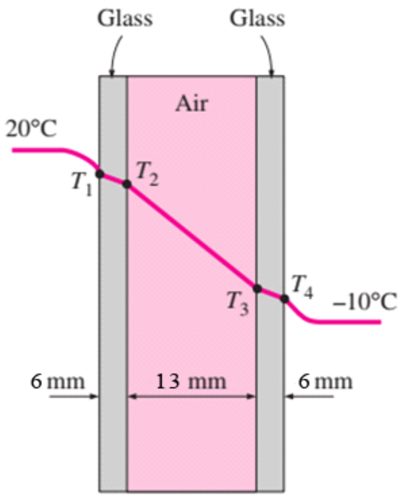
$$R_{conv_1} = \frac{1}{h_1 \times A} = \frac{1}{(10 * 1.2)} = 0.0833\ °C/W$$

$$R_{conv_2} = \frac{1}{h_2 \times A} = \frac{1}{(40 * 1.2)} = 0.0208\ °C/W$$

$$R_{tot} = R_{conv_1} + R_{conv_2} + 2 \times R_g + R_{airGap}$$
$$= 0.0833 + 0.0208 + 2 * 0.0064 + 0.4167 = 0.5336\ °C/W$$

$$\dot{Q} = \frac{\Delta T}{R_{Tot}} = \frac{30}{0.5336} = 56.22\ W$$

$$\dot{Q} = \frac{T_{inff_1} - T_{s_1}}{R_{conv_1}} = \rightarrow 56.22 = \frac{20 - T_{s_1}}{0.0833} \rightarrow T_{S_1} = 15.31\ °C$$



→ As we can seen from the result we have an optimal range for the air-gap's distance because the thermal conductivity coefficient of the air (K) is very low then its convection resistance is very hight. The air gap is the element that helps the window in the resistance to convection.