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1. CONVECTIVE HEAT TRANSFER

Convection is the capacity to transfer heat through liquids o gases (fluid materials) There are two types of convection:

- Force: Due to an external force that produce the phenomenon.
- Natural: Due to the change of density, the hot air goes up and the cold air goes down.

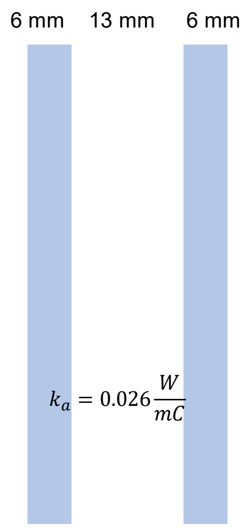
The rate of heat convection depends of three factors: the difference on temperature, the velocity and the type of liquid or gas.

Newton's law of cooling indicates that the rate of heat convection is directly proportional to a constant, depending on each material, the area of the surface directly affected and the variation of temperature. In other words, it is directly proportional to the variation of temperature and inversely proportional to the total resistance of the material.

On a real situation, conduction and convection act together in the same situation. For instance, between an interior and an exterior, acts a convection heat transfer on the interior space until the surface of the solid material, where conductive heat transfer goes along the solid material and finally in the exterior acts another convection heat transfer.

Increasing the thickness of a single pane of glass is not representative in the improvement of total resistance because the constant (k) proper of each material is near to 1 and it is not important in the division. The fact that is really representative in the improvement of the total resistance is the area of the surface, if it goes down, the resistance will rise.

EXERCISE



$A = 1.2\,m^2$

$T_1 = 20\,C$

$T_1 = -10\,C$

$h_1 = 10\dfrac{W}{m^2C}$

$k_a = 0.026\dfrac{W}{mC}$

$h_2 = 40\dfrac{W}{m^2C}$

$k_g = 0.78\dfrac{W}{mC}$

$$R_{total} = R_{conv1} + R_{g1} + R_a + R_{g2} + R_{conv2}$$

$$R_{total} = 0.0833 + 0.0064 + 0.4166 + 0.0064 + 0.0208$$

$$\boxed{\boldsymbol{R_{total} = 0.5335\frac{C}{W}}}$$

$$R_{conv1} = \frac{1}{hA} = 0.0833\frac{\mathrm{C}}{\mathrm{W}}$$

$$R_{g1} = \frac{L}{kA} = 0.0064\frac{\mathrm{C}}{\mathrm{W}}$$

$$R_a = \frac{L}{kA} = 0.4166\frac{\mathrm{C}}{\mathrm{W}}$$

$$R_{conv2} = \frac{1}{hA} = 0.0208\frac{\mathrm{C}}{\mathrm{W}}$$

$$Q = \frac{T_1 - T_2}{R_{total}}$$

$$Q = \frac{20C - (-10C)}{0.5335\frac{C}{W}}$$

$$\boxed{\boldsymbol{Q = 56.23\,W}}$$

The increase of the glass thickness is not representative in the increase of the total resistance due to the properties of the material, which has not a good thermodynamic behavior. His resistance value is the lowest among the different layers we are studying: Air in interior conditions, glass, air camera, air in exterior conditions.

On the other hand, increasing the air gap distance improves the total resistance in an amount higher than the resistance provided by the glass. The effect of the glass is to produce the air camera in which the resistance is even higher than outside the wall.

If the air-gap distance increases, the air located in the camera between both glasses will start moving as fluid and stop working as a solid material. In that case, the resistance in the air gap, will decrease considerably.