OZYURT Azra - Week 2

13 Ekim 2019 Pazar 14:27

Convection is one of the ways for heat to move from one fluid to another, such as from gas to gas; from liquid to gas, gas to gas etc.
Convection in general can be explained as a circular motion that happens in a space which holds different energy loaded molecules. When a molecule has less energy therefore colder, it tends to move down. Yet if molecules have more energy therefore warmer, they tend to rise. This is caused by the density of the molecules. Cold molecules tend to have higher density whereas warmer molecules has lower density.

There are two tyes of convection to be observed: natural convection and forced convection.

Natural convection occurs only beacuse of the densities of the fluids moving and exchanging heat in between one another. There are no external forces involved, the movement is caused only by the difference of heat and therefore density.

Forced convection occurs by some external forces such as wind. When external forces makes the fluids move and the transfer is not caused only by heat transfer and density difference but by the external force like wind, forced convection occurs.

Why increasing the thickness of the glass in a window will not effecively change resistance of the system?

This can be explained by combining two aspects: one is the nature of the resistance which has direct propotions to thickness and indirect propotions to conductiveness of the material and area which is exposed. When seen like this, one can think that increasing the thickness will effect the resistance of a glass but when calculated with the true "k" values we come to the conclusion that it actually will not effect the resistance more than 0,002 units. In order to make this effective number bigger, k needs to get so high that it will not be feasible to create a glass that thick, which brings us to the second aspect. Instead of increasing thickness of the glass, using double pane glass with void or air inside is a better solution.

Reason of mistakes made in in-class questions:
Miscalculation caused by not writing the number right. For example I did the rounding of 0.083333333 as 0.8333.

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 h1= 10 W/m2 · °C and h2=40 W/m2 · °C, which includes the effects of radiation.

The total resistance

$A = \ 0.8 * 1.5 = 1.2$

$R_{g_1} = R_{g_2} = \frac{L_g}{K_g \times A} = \frac{0.004}{0.78 * 1.2} = 0.0043\ ° \frac{C}{W}$

$R_{airGap} = \frac{L_{airGap}}{K_{airGap} \times A} = \frac{0.013}{0.026 * 1.2} = 0.4166\ °C/W$

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

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

$R_{tot} = R_{conv_1} + R_{conv_2} + 2 \times R_g + R_{airGap}$

$= 0.0833 + 0.0208 + 2 * 0.0043 + 0.4166 = 00.5459° \frac{C}{W}$

$\dot{Q} = \frac{\Delta T}{R_{Tot}} = \frac{30}{0.5459} = 54.59\ W$

$\dot{Q} = \frac{T_{inff_1} - T_{s_1}}{R_{conv_1}} =\rightarrow 54.59 = \frac{20 - T_{s_1}}{0.0833} \rightarrow T_{S_1 = 15.46\ °C}$

From this conclusion and the previous examples solved, the phenomenon of effecive thickness of glass comes to mind which can be unterstood from the production of window pane glass. They are in the range of 6mm and 13mm. This is the most effective gap by means of cost of making the glass but also the durability of the glass.