Assignment 2

1. Convective heat transfer

Convective heat transfer represents a movement of a fluid, like water or air, and it takes place when warmer parts of fluid (or gas) move to cooler areas. Convection can also occur between a solid and a gas. It that case, hot liquid or air rises and cooler moves down. This happens in a continuous circle and by that the convection is a circulation in which heat is transferred to cooler areas.

Moreover, there are two types of convection including natural convection and covnection caused by force. That being said, natural convection takes place between two fluids or a moving fluid and a solid. In both times there is a difference in temperature and the heat is transferd from warmer to cooler part without any outdoor (external) force. Forced convection occurs between two liquids or a moving liquid and a solid due to external force.

Energy loss happens in single pane glass regardless the thickness of the glass, because neither the material nor its thickness reduces the amount of energy loss (because of low general thermal resistance of the gas)

2. Class work revision:

I was at the lecture during the interactive solving of the problem and during the work related to the example B and I understood it very well, so I did not made errors in the process of solving this example. However I was not able to be present during calculation of Example C but with all materials uploaded on Dropbox I was successful in solving this weeks' assignment.

3. Question:

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.

Total area:

$$A = \ 0.8 * 1.5 = 1.2$$

Conduction of a 6-mm glass layers:

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

Resistance of the conduction of air gap:

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

Convection between inner air and the glass:

$$R_{conv_1} = \frac{1}{\mathrm{h}_1 \times A} = (\frac{1}{10 * 1.2}) = 0.0833\ °C/W$$

Convection between oughter air and the glass:

$$R_{conv_2} = \frac{1}{\mathrm{h}_2 \times A} = (\frac{1}{40 * 1.2}) = 0.0208\ °C/W$$

Thermal resistance of the window:

$$R_{total} = R_{conv_1} + R_{conv_2} + 2 \times R_g + R_{airGap} = 0.0833 + 0.0208 + 2 * 0.0064 + 0.4166 = 0.5335\ °C/W$$

Heat transfer through the window:

$$\dot{Q} = \frac{\Delta T}{R_{Total}} = \frac{30}{0.5335} = 56.23\ W$$

Inside temperature of the surface:

$$\dot{Q} = \frac{T_{inff_1} - T_{s_1}}{R_{conv_1}} = \rightarrow 56.23\ \mathrm{W} = \frac{20 - T_{s_1}}{0.0833} \rightarrow T_{S_1} = 15.31°C$$

The air trapped between the two panes helps reduce heat loss, acting as a barrier that keeps in the warm air on the inside.