ASSIGMENT 2 (WEEK 2)

1.1. Summary about convective heat transfer

The transfer of heat is normally from a high temperature object to a lower temperature object. Heat transfer changes the internal energy of both systems involved according to the First Law of Thermodynamics.

Convective heat transfer, in other words heat convection, is one of the three ways of transfer heat. Convective heat transfer results from fluid moving across a surface that carries heat away, meaning it happens between two moving fluids (for example liquid and gas, liquid and liquid, gas and gas), or a solid and a moving fluid (gas and solid for example). Convection above a hot surface occurs because hot air expands, becomes less dense, and rises. Hot water is likewise less dense than cold water and rises, causing convection currents which transport energy.

In this type of heat transfer a key problem is determining the boundary conditions at a surface exposed to a flowing fluid. An example is the wall temperature in a turbine blade because turbine temperatures are critical for creep life.

There are many examples of Convection in everyday life such as:

- Boiling water - The heat passes from the burner into the pot, heating the water at the bottom. Then, this hot water rises and cooler water moves down to replace it, causing a circular motion.
- Steaming cup of hot tea - The steam is showing heat being transfered into the air.
- Ice melting - Heat moves to the ice from the air. This causes the melting from a solid to liquid.

There are also two types of convection: free or natural convection and forced convection.

1.2. Why increasing the thickness of a single pane glass does not increase the total resistance?

The thermal resistance of glass is a of a small value compared to the thermal resistance of convection between glass and air. Increasing the thickness of a single pane glass can increase the thermal resistance of the glass, but it does not significantly increase the total thermal resistance.

2. Review of the mistakes

The fisrt part of the assigments I did correct and the later ones I was not confident in my answers. Maybe I just was not concentrating enough. But doing it together after everyone typed theirs online really helped.

3. Problem

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°CC) separated by a 13-mm-wide stagnant air space (k=0.026 W/m°CC). 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 $WWmm2°CC$ and h2= 40 $WWmm2°CC$, which includes the effects of radiation.)

Total area:

$A = \ 0.8 * 1.5 = 1.2$

Conduction of a 6-mm glass layers:

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

Resistance of the conduction of air gap:

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

Convection between inner air and the glass:

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

Convection between oughter air and the glass:

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

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 reduces the heat loss, acting as a barrier that keeps the warm air inside.