Week Assignment 2

Question 1

Write a summary in your own words about the convective heat transfer (half a page) and explain why increasing the thickness of a single pane glass does not increase the total resistance

Answer

Convection is defined as the heat energy transferred between a surface and a moving fluid with difference in temperatures. There are two types of convection, which are forced or assisted convection and natural or free convection.

Forced or assisted convection occurs when the flow of fluid is induced by an external force.

At heating the density change in the boundary, the heated fluid tends to rise higher and this will be replaced my cooler air. This is a continuous process. This kind of phenomena is called natural or free convection.

In general, boiling or condensing processes can be referred as examples for conductive heat transfer process.

$$R_g = \frac{L}{(K \times A)}$$

From the above, we can see that the thermal resistance of glass is directly proportional to the thickness of the glass. And also thermal resistance of the glass is very small compared to the thermal resistance of convection between glass and air. Therefore, an increase in the thickness of the glass would have an impact only on the thermal resistance of the glass but not the total thermal resistance.

Question 2

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

Answer

1. For the multi layer type of problems, while calculating I did not multiply the resistance of air twice which lead to a different answer.
2. For the thickness on the glass, at times I forget to convert millimetres to meters.
3. I rounded off the decimal numbers to the nearest round figure two numbers after decimal instead of four decimal points due to which my answers were varied in the class.

Question 3

Solve the same problem as that of double pane window with the air-gap thickness of 13 mm and glass thickness of 6 mm, comment on your results and explain why we have an optimal range for the air-gap's distance

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.

Answer

A= 0.8m x 1.5m=1.2m

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

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

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

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

$$R_{tot} = R_{conv_1} + R_{conv_2} + 2 \times R_g + R_{airGap} = 0.5336\frac{C}{W}$$

$$\dot{Q} = \frac{\Delta T}{R_{Tot}} = \frac{20 - (-10)}{0.5336} = 56.22W$$

$$\dot{Q} = \frac{T_{inff_1} - T_{s_1}}{R_{conv_1}} \rightarrow 56.22 = \frac{20 - T_{s_1}}{0.0833} \rightarrow T_{S_1=15.3\,°C}$$