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Submission Date: 15/10/2019
Assignment #: 2nd Week

Summary

Convection is another way of heat transfer between two substances. Unlike conductivity which happens due to direct physical contact of two bodies, convection occurs indirectly by motion within fluids (liquid and gas) or between a surface of a solid material and a fluid which is spread over. As well as conduction, convection also happens because of temperature difference (naturally or by force) which makes the heat transfer from a hotter object to the cooler one. Convection heat transfer depends on four main factors:

1- Surface area where the heat transfer occurs
2- Temperature of the surrounding fluid
3- Temperature of the surface
4- heat transfer coefficient which depends on the type of fluid.

Question 1: Why increasing the thickness of a single pane glass does not increase the total residence?

Glass has a low thermal conductivity (k) which is a decimal number. Increasing the thickness of the glass (L) can definitely affect the thermal resistance (R) of the glass itself but won't have a significant affect on the total residence value since it's a very small number.

Mistakes During Class

I was absent at this session but mostly I had simple mathematical mistakes during the process of solving equations at home. Also the inner and outer surface temperature and choosing the right temperature for the final equation was a bit confusing at the beginning.

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Exercise

1- Steady Rate of Heat Transfer

- $$\dot{Q} = \frac{T_{\infty 1} - T_{\infty 2}}{R_{total}}$$
- $$R_{total} = R_{conv\,1} + R_{glass\,1} + R_{air} + R_{glass\,2} + R_{conv\,2}$$

$$R_{total} = \frac{1}{h_1 A} + \frac{L_{glass1}}{k_{glass1} A} + \frac{L_{air}}{k_{air} A} + \frac{L_{glass2}}{k_{glass2} A} + \frac{1}{h_2 A}$$

$$\dot{Q} = \frac{T_{\infty 1} - T_{\infty 2}}{\frac{1}{h_1 A} + \frac{L_{glass1}}{k_{glass1} A} + \frac{L_{air}}{k_{air} A} + \frac{L_{glass2}}{k_{glass2} A} + \frac{1}{h_2 A}}$$

$$\dot{Q} = \frac{20 - (-10)}{\frac{1}{10 \times (0.8 \times 1.5)} + \frac{0.006}{0.78 \times (0.8 \times 1.5)} + \frac{0.013}{0.026 \times (0.8 \times 1.5)} + \frac{0.006}{0.78 \times (0.8 \times 1.5)} + \frac{1}{40 \times (0.8 \times 1.5)}}$$

$$\dot{Q} = \frac{30}{0.0833 + 0.0064 + 0.4166 + 0.0064 + 0.0208}$$

$$\boxed{\dot{Q} \approx 56.23\ \text{W}}$$

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1- Temperature of the inner surface

$$\dot{Q} = \frac{T_{\infty 1} - T_1}{R_{conv\,1}}$$

$$T_1 = T_{\infty 1} - \left(\dot{Q} \times R_{conv\,1}\right)$$

$$T_1 = 20 - \left(56.23 \times \frac{1}{10 \times (0.8 \times 1.5)}\right)$$

$$T_1 \approx 15.3\,°C$$

Question 2: Why is there an optimal range for the air gap's distance in double pane windows?

Since there is no motion within air's gap, heat is formally transferred in conduction mode. Low thermal conductivity of air slows the heat transfer process and according to this, the more the distance is the less should be the amount of heat loss but this is not always true. Exceeding a certain range (typically 13 mm) can cause convection currents which leads to certain amount of heat loss and reduces the effect of the air gap in double pane windows.