WEEK 2_ZHU CUILING

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1-a. Summary about the convective heat transfer

Convective heat transfer is a basic way of heat transfer, divided into natural convection and forced convection. This is because the cause of fluid motion is different. If the fluid motion is caused by a difference in local density caused by the temperature difference inside the fluid, it is called natural convection. If the fluid moves due to the action of a water pump, fan or other external force, it is called forced convection.

What we need to highlight is that convective heat transfer is relying on the movement of fluid particles for heat transfer, so it is depends on: 1) temperature, 2) velocity of liquid or, 3) kind of liquid or gas.

The convective heat transfer coefficient refers to the heat transfer capacity between the fluid and the solid surface. The basic calculation formula for convective heat transfer coefficient was proposed by Newton in 1701, also known as Newton's law of cooling. Newton pointed out that the heat flow of convective heat transfer between the fluid and the solid wall is proportional to their temperature difference.This formula is:

$$\dot{Q}_{conv} = h \times A_s \times (T_s - T_\infty)$$

$$\dot{Q}_{conv} = \frac{T_s - T_\infty}{R_{conv}}$$

$$R_{conv} = \frac{1}{h \times A_s}$$

The thermal resistance network for heat transfer through a plane wall subjected to converction on both side, and the eletrical analogy. Such as:

$$\dot{Q} = \frac{T_{\infty 1} - T_1}{R_{conv,1}} = \frac{T_1 - T_2}{R_{conv,wall}} = \frac{T_2 - T_{\infty 2}}{R_{conv,2}} \quad \rightarrow \quad \dot{Q} = \frac{T_{\infty 1} - T_{\infty 2}}{R_{total}}$$

The summery of caculated test which we learned in the class is: actually the thermal resistance of wall is less than the thermal resistance of air, and the thermal resistance of glass could nearly be ignored, bcause it nearly don't affect the total resistance.

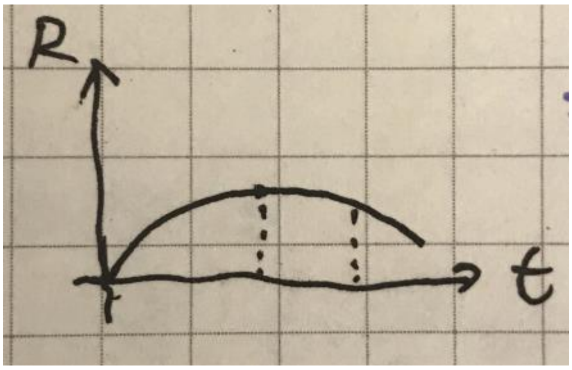
We can also use this formula to caculate the surface temperature, such as:

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

$$T_2 \ \rightarrow \ \dot{Q} = \frac{T_{\infty 1} - T_2}{R_{conv,1} + R_{wall}}$$

$$T_3 \ \rightarrow \ \dot{Q} = \frac{T_3 - T_{\infty 2}}{R_{conv,2}}$$

Air convection curve in double glazing:



As the distance increases, there is a critical point in the air convection influence curve.

b. Explain why increasing the thickness of a single pane glass does not increase the total resistane

Because the heat resistance coefficient of glass itself is not on the same order of magnitude as other materials, which is equivalent to one tenth or one percent of the heat resistance coefficient of other materials, the effect of glass thickness increase on the entire resistance is minimal.

2- An explanation about what mistakes you made in the class that resulted in wrong answers.

Because I made a mistake when converting the unit, 1mm = 0.001m, I mistakenly thought that 1mm = 0.01m.

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

Consider a 0.8m high and 1.5m wide double-pane windiw consisting of two 6-mm-thick layers of glass(k=0.78 W/$m^2 \cdot$°C) separated by a 13-mm-wide stagnant air space(k=0.026 W/$m^2 \cdot$°C). Determine the steady rate of heat transfer through this double-pane window and temperature of its inner surface.Take the convection heat transfer coefficent on the inner and outer surface of the window to be h_1=10 W/$m^2 \cdot$°C and h_2=40 W/$m^2 \cdot$°C, which includes the effects of radiation.

$\mathrm{A} = 0.8 \times 1.5 = 1.2m^2$

$$R_{total} = R_{conv,1} + R_{glass,1} + R_{glass,2} + R_{conv,2}$$
$$= \frac{1}{h_1 \times A} + \frac{L_1}{k_1 \times A} + \frac{L_2}{k_2 \times A} + \frac{L_1}{k_1 \times A} + \frac{1}{h_2 \times A}$$
$$= \frac{1}{10 \times 1.2} + \frac{0.006}{0.78 \times 1.2} + \frac{0.013}{0.026 \times 1.2} + \frac{0.006}{0.78 \times 1.2} + \frac{1}{40 \times 1.2}$$
$$\approx 0.0833 + 0.0064 + 0.4167 + 0.0064 + 0.0208 \approx 0.5336$$

$$\dot{Q}_{conv} = \frac{T_s - T_\infty}{R_{conv}} = \frac{20-(-10)}{0.5336} \approx 56.22W$$

$$56.22 = \frac{T_{\infty 1} - T_1}{R_{conv,1}} \quad \rightarrow \quad T_1 = 20 - (56.22 \times 0.0833) = 15.3°\mathrm{C}$$