WEEK2_HOMEWORK_ZHAOXINYU_10709945

1. Write a summary (in your own words !!!) about the convective heat transfer (half a page)

CONDUCTION: heat transfer in solids

CONVECTION: heat transfer in liauids or gases.(air)

-Natural Convection: - increase in temperature

-reduction in density (hot air goes up, cold air goes down)

-Forced Convection (wind)

STEADY STATE HEAT CONVECTION:

-Find how fast air is moving through the wall

-Rate of heat loss combined conduction and convection

$\dot{Q} = \frac{T_{\infty 1} - T_1}{R_{conv1}}$ (w) T_{∞}: far from the wall (not affect)

$\mathrm{R_{conv}} = \frac{1}{\mathrm{h_1 \cdot A}}$ (℃/W) h : convection heat transfer coefficient usually already given

-Force (wind) convection is higher - Natural (no wind) convection is lower

Thermal resistance network : for now, we don't take radiation in account.

$T_{\infty 1}$: temperature of the inside (air)

$T_{\infty 2}$: temperature of the outside (air) *coldest day worst case scenarlo

$\dot{Q} = \frac{T_{\infty 1} - T_{\infty 2}}{R_{conv1} + R_{wall} + R_{conv2}}$

$\mathrm{R_{total}} = \mathrm{R_{conv1}} + \mathrm{R_{wall}} + \mathrm{R_{conv2}} = \frac{1}{\mathrm{h_1 \cdot A}} + \frac{\mathrm{L}}{\mathrm{k \cdot A}} + \frac{1}{\mathrm{h_2 \cdot A}}$ （℃/W）

A: area of the wall is always the same

$\triangle \mathrm{T} = \dot{Q} \cdot R_{total}$ (℃)

$\dot{Q} = \mathrm{U \cdot A} \bullet \triangle \mathrm{T}$

$\mathrm{U \cdot A} = \frac{1}{\mathrm{R_{total}}}$

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

According to the formula R=L/kA, the thickness L of glass does have an effect on the overall thermal resistance R, but the effect of it is very small. Although increasing the thickness of glass, it increases a few millimeter only. For instance, compared with the thickness of wall, the glass still is thinner, and it only can affects total heat resistance in a useless way . Therefore, increasing the thickness of glass has little effect on the total thermal resistance.

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

In the calculation, I need to pay attention to the conversion of units. For example, 1 millimeter

equals 0.001 meters ,instead of 0.01 meters.

At the same time, I must be skilled in the application of formula deformation. When I caculate temperature, according to the formula $\mathrm{T}_1 - T_{\infty 1} = \dot{Q} \cdot R_{conv1}$ concluded $\mathrm{T}_1 = T_{\infty 1} - \dot{Q} \cdot R_{conv1}$

3. Solve the same probelm as that of double pane window with with the air-gap thickness of 13 mm and glass thickness of 6 mm, commment on your results

QUESTION:

Consider a 0.8m high and 1.5m wide double-pane window consisting of two 6mm thick layers of glasss (k=0.78W/m℃) separated by a 13mm wide stagnant air space(k=0.026W/m℃).Determine the steady rate of heat transfer through this double-pane window the temperture if its inner surface. (Take the convection heat transfer coefficients on the inner and outer surfaces of the window to be $\mathrm{h}_1 = 10\frac{w}{m℃}$ and $\mathrm{h}_2 = 40\frac{w}{m℃}$,which includes the effects of radiation.)

ANSWER:

A= 0.8m • 1.5m =1.2 ㎡

$$\mathrm{R}_{\mathrm{conv1}} = \frac{1}{\mathrm{h}_1 \cdot \mathrm{A}} = \frac{1}{10 \cdot 1.2} = 0.0833\frac{℃}{\mathrm{W}}$$

$$\mathrm{R}_{\mathrm{glass1}} = \frac{\mathrm{L}_{\mathrm{glass1}}}{\mathrm{k}_{\mathrm{glass1}} \cdot \mathrm{A}} = \frac{0.006}{0.78 \cdot 1.2} = 0.0064\frac{℃}{\mathrm{W}}$$

$$\mathrm{R}_{air} = \frac{\mathrm{L}_{\mathrm{air}}}{\mathrm{k}_{\mathrm{air}} \cdot \mathrm{A}} = \frac{0.013}{0.026 \cdot 1.2} = 0.4167\frac{℃}{\mathrm{W}}$$

$$\mathrm{R}_{\mathrm{glass2}} = \frac{\mathrm{L}_{\mathrm{glass2}}}{\mathrm{k}_{\mathrm{glass2}} \cdot \mathrm{A}} = \frac{0.006}{0.78 \cdot 1.2} = 0.0064\frac{℃}{\mathrm{W}}$$

$$\mathrm{R}_{\mathrm{conv2}} = \frac{1}{\mathrm{h}_2 \cdot \mathrm{A}} = \frac{1}{40 \cdot 1.2} = 0.0208\frac{℃}{\mathrm{W}}$$

$\mathrm{R}_{\mathrm{total}} = \mathrm{R}_{\mathrm{conv1}} + \mathrm{R}_{\mathrm{glass1}} + \mathrm{R}_{\mathrm{air}} + \mathrm{R}_{\mathrm{glass2}} + \mathrm{R}_{\mathrm{conv2}} = 0.0833 + 0.0064 + 0.4167 + 0.0064 + 0.0208 = 0.5336\mathrm{W}$

$$\dot{Q} = \frac{T_{\infty 1} - T_{\infty 2}}{R_{total}} = \frac{20\ ℃ + 10\ ℃}{0.5336} = 56.2219W$$

$$\dot{Q} = \frac{T_{\infty 1} - T_1}{R_{conv1}}$$

$$\dot{Q} \cdot R_{conv1} = T_{\infty 1} - T_1$$

$$T_1 = T_{\infty 1} - \dot{Q} \cdot R_{conv1} = 20\ ℃ - 56.2219 \cdot 0.0833 = 15.32\ ℃$$

Explain why we have an optimal range for the air-gap's distance

Convective heat transfer occurs inside gap, when the distance between the two layers of glass is 6mm. However, when the distance is larger than 13mm, here hot convection causes air to move

too quickly inside the gap.