Technical Environmental System

Monday, October 14, 2019 11:44 PM

Week2_nkiarostami

1. Summary of Conductive Heat Transfer

Convective Heat Transfer is the transfer of heat between two component: fluids (gas or liquids) and a solid surface (for example wall) because of the temperature difference. The heat transfers from the warmer place to cooler place by the movement of fluids. For example when you put a kettle of water on fire the kettle surface (solid surface) in contact with fire becomes hot and the water inside the kettle that is in contact with the inner surface of the kettle becomes warmer and the warm water goes to the upper surface and the cooler water goes down and this happens over and over till there is no more temperature difference.
There are two type of convection:

- Natural Heat transfer: In this case, currents were produced through temperature-derived density difference. Warm air goes up and cold air goes down. No external interferences are noticed.
- Forced Heat Transfer: In this case, heat transfer is affected by external factors such as a pump
  Or natural wind effect.

To calculate the steady rate of heat transfer, we use the following formula to calculate the total resistance of the item in subject, which is the sum of all resistances in place (convection and conduction). Than we calculate the steady heat transfer rate (Q dot)

R total = R conv.1 + R cond. + R conv.2 (C/W)

$$\dot{Q} = \frac{\Delta T}{R_{total}}$$

Q̇: Steady rate of heat transfer (W)
R: thermal resistance (°C/W)
K: thermal conductivity (W/m.°C)
DT: Difference of temperature (°C)
A: Area (m2)
h: convective heat transfer (W/m.°C)

Why increasing the thickness of the glass pane does not increase the total?

The thickness of a single pane glass, if increased, will not increase the total resistance . It sure will technically slightly increase the thermal resistance of the glass, but even if, it will remain

very small compared to other thermal resistances, such as the one happening from the inside and outside.
To increase the total resistance of a window, the best way is to use a double-glass window with an air layer in between the two glasses. Because

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

I didn't make much mistakes. The only mistake was because of some calculation mistakes.

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 distance.

Calculation the thermal resistance of the double pane glass

$$R_{total} = R_{conv,1} + R_{wall} + R_{conv,2} = \frac{1}{h_1 A} + \frac{L}{kA} + \frac{1}{h_2 A} \quad (°C/W)$$

R convection (inside) = 1/h1.A= 1/(10*1.2)=0.0833
R conduction (1st pane of glass)= L/Kglass.A= 0.006/(0.78*1.2)=0.0064
R conduction (air gap)= L/Kair.A= 0.013/(0.026*1.2)=0.4167
R conduction (1st pane of glass)= L/Kglass.A= 0.006/(0.78*1.2)=0.0064
R convection (outside)= 1/h2.A= 1/(40*1.2)=0.0208

The total thermal resistance is equal to: R conv.1+R cond. 1+ R cond.2+Rcond.3+R conv. 2=0.5338 C/W

Calculating the Steady rate of Heat transfer

$$\dot{Q} = \frac{\Delta T}{R_{total}}$$ Q̇= 20+10/0.5338=56.2008

Calculating the inside surface temperature of the glass

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

56.2008=(20 C-Ts1)/0.0833
(20 -Ts1)= 56.2008*0.0833=4.6815

Temperature of the inside glass surface= 20-4.68=15.32 C

Ts1 (glass thickness 4mm)=14.2 C
Ts1 (glass thickness 6 mm)= 15.32C
R conduction Glass 4mm=0.0042 C/W
R conduction Glass 6mm=0.0064 C/W
R conduction Air gap 10 mm=0.3205 C/W
R conduction Air gap 13 mm=0.4165 C/W

Note that when we enlarged the thickness of our glass from 4 mm to 6mm, R has slightly risen (little effect on the total result), however when we our air gap from 10mm to 13 mm, R has intensely risen, which concluded the major difference in the total result.

Conclusion: it is not the thickness of the glass that played a major role in the thermal resistance of the double glazed window, but it's the air gap in between the two panes.