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11:29 AM

1- Summary of Convective Heat Transfer

Convective heat transfer, caused by a difference of temperature between two components, also called convection, is a transfer of heat from a warm place to a cold place by the of fluids (liquids, and gases), and/or the movement of fluids in contact with a solid. is generally accompanied with conduction (taking the example of the kitchen kettle, or a pot filled by water placed on the cooktop, water will boil inside the kettle, inducing the cover to heat as well)

Two types of Convection exist:

1- Natural convection (no external interference: warm air goes up and cold air goes
2- Force convection (wind, water pump)

The formula for convective heat transfer is:

$$\dot{Q} = \frac{T_{\infty 1} - T_{\infty 2}}{R_{\text{total}}}$$

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

h: convective heat transfer coefficient (W/m2.C)
ΔT: difference of temperature (inside – outside) ©

A: area (m2)
K: thermal conductivity (W/m.C)
R: steady rate of heat transfer (C/W)

(h) Convective heat transfer coefficient is dependent upon the physical properties of the and the physical situation.

Why increasing the thickness of a single pane glass does not increase the total

The thickness of the glass pane is relevant to L (width of the glass pane), increasing L will have little to no effect on the total result of the formula. Thermal resistance of the glass, even if the thickness is increased will remain very small compared to the R convection (air-glass). Rather, will be better to use a double pane glass, with a void between the two layers of glass, and calculate the formula (R total= R conve. 1 + R cond. 1 + R cond. 2 + R cond. 3 + R conve.), that R air between the two panes is conduction heat transfer, and not convection since the air stagnant, the results in that case will be better compared to the first formula mentioned above

calculating with a thicker glass.

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

A mistake I made in class, was while calculating the heat transfer steady rate R total (C/M), for double pane glass system, in the R of the air between the two panes. I calculated it as R convection and not as R conduction, neglecting the effect of being stagnant. So I got different results. Now, I will always remember that heat transfer through air void between two panes of glass in Double glazinf system is conduction, and not convection.

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 !**

Area: 0.8 * 1.5 = 1.2 1.2 m2

R convection 1 = 1/h1A = 1/(10*1.2)=0.0833
R conduction glass = L/K1A= 0.006/(0.78*1.2)=0.0064
R conduction air= L/K2A= 0.013/(0.026*1.2)=0.4167
R conduction glass = L/K1A= 0.006/(0.78*1.2)=0.0064
R convection 1 = 1/h2A = 1/(40*1.2)=0.0208

Total Thermal Resistance:

R total= R conv 1 + R cond 1 + R cond 2 + R cond 3 + R conv 2
R total= 0.0833+0.0064+0.4167+0.0064+0.0208=0.5336 C/W

Steady Rate of heat Transfer:

$$\dot{Q} = \frac{T_{\infty 1} - T_{\infty 2}}{R_{\text{total}}}$$

= 30/0.5336 = 56.2219 W

Calculate the temperature of the interior surface of the glass:

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

56.2219 = (20- T1)/0.0833
20-T1= 56.2219*0.0833=4.6833
T1= 20-4.6833=15.3167 C

Comparing T1 in this w=example with T1 in the example made in class, T1 one here is greater than the other one. So the thermal resistance of the window if made with a 13mm air gap, and 6mm glass panes is better.