Week 2

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1. Summary

Convection heat transfer, one of the three ways of heat transfer, refers to the heat transfer process caused by the relative displacement of each part of the fluid which resulting in the mixing of fluid with different temperatures.

Convection heat transfer can be divided into forced convection and natural convection. Forced convection is the circulation of a fluid produced by an external force. Natural convection is usually the result of the difference in temperature. When a part of a fluid, such as a liquid or gas, is heated, its volume expands, its density decreases, its weight decreases, and so it gradually go up. The vacancy is filled by the surrounding material with lower temperature and higher density, which is heated up and rise again and its vacancy would be supplemented by the other surrounding materials. This circulation allows the fluid to flow naturally

The factors influencing convective heat transfer are as follows: physical properties of fluid, such as specific heat capacity, thermal conductivity, density, etc. Geometric characteristics of heat transfer surface, such as shape, size, etc.

The reason why increasing the thickness of a single pane glass dose not increase the total resistance is that: The air conductivity is too low and the resistance of the air-gap is large enough, the resistance of the glass is too small to be neglected. Therefore, the increase in thickness of glass can only cause negligible impact on the total resistance. However, the air-gap should be maintained at a certain distance, otherwise the air will generate convection and greatly reduce the thermal resistance.

2. About the mistake

Miscalculation.

3. Exercise

T_1=20℃, T_4=-10℃

h_1=10W/m^2℃, h_2=40W/m^2℃

$L_{(glass)}$=0.006m, $L_{(air)}$=0.013m

$k_{(glass)}$=0.78 W/m·℃, $K_{(air)}$=0.026 W/m·℃

0.8 high and 1.5 width

A=0.8x1.5=1.2 m^2

$R_{total}=R_{conv,1}+R_{glass*2}+R_{air}+R_{conv,2}$

$$=\frac{1}{h_1 A}+\frac{L_{glass}}{k_{glass}A}*2+\frac{L_{air}}{k_{air}A}+\frac{1}{h_2 A}$$

$$=\frac{1}{10*1.2}+\frac{0.006}{0.78*1.2}*2+\frac{0.013}{0.026*1.2}+\frac{1}{40*1.2}$$

≈ 0.5328 ℃/W

$$Q = \frac{T_{\infty 1} - T_{\infty 2}}{Rtotal} = \frac{20-（10）}{0.5328} = 56.3W$$

$T_1 = T_{\infty 1}$-Q* $R_{conv,1}$ = 20-56.3*0.0833 = 15.31 ℃

(consider that the air layer in the middle have no conductivity)

If the air-gap have not maintained at a certain distance, it would generate convection and greatly reduce the thermal resistance, so there is an optimal range for air-gap's distance.