

9 OCTOBER: Newton's law of cooling

Convection of molecules.
when we warm Air. the density become lighter and go up so this cycle continue.

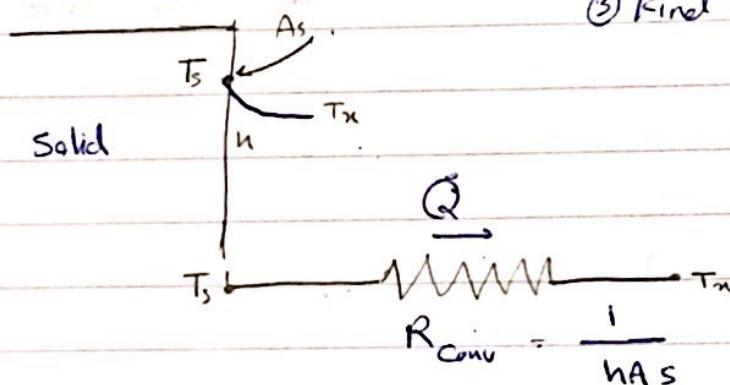
$$Q_{\text{conv}} = h A_s (T_s - T_a)$$

- 2 Type of convection:
 - 1 natural
 - 2 forced.

$$Q = \frac{T_s - T_a}{R_{\text{wall}}} \quad (\text{W})$$

- Rate of convection heat transfer depends on:
 - 1 different temperature
 - 2 velocity of liquid or gas
 - 3 kind of liquid or gas

$$R_{\text{wall}} = \frac{1}{h A_s} \quad (^\circ\text{C/W})$$



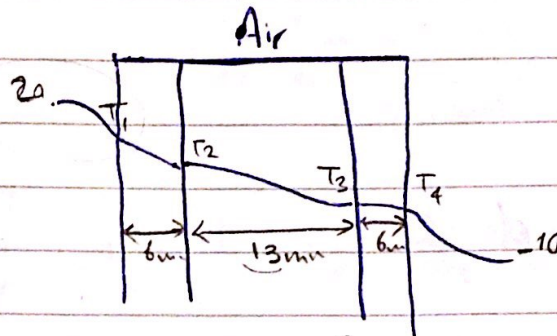
Convection resistance of the surface: convection
thermal resistance of the surface against heat

$$\left(\text{Rate of heat convection into wall} \right) = \left(\text{Rate of heat conduction through the wall} \right) = \left(\text{Rate of convection from the wall} \right)$$

$$Q = \frac{T_{\infty 1} - T_1}{1/hA} = \frac{T_1 - T_2}{L/KA} = \frac{T_2 - T_{\infty 2}}{1/hA}$$

$$\frac{T_{\infty 1} - T_1}{R_{\text{conv}1}} = \frac{T_1 - T_2}{R_{\text{wall}}} = \frac{T_2 - T_{\infty 2}}{R_{\text{conv}2}}$$

Exercise:



$$\begin{aligned}
 R_{\text{conv } 1} &= \frac{1}{hA} = \frac{1}{10(1,2)} = 0,0833 \text{ } ^\circ\text{C}/\text{W} \\
 R_{\text{wall } 1} &= \frac{L}{kA} = \frac{0,006}{0,78 \times 1,2} = 0,0064 \\
 R_{\text{wall } 2} &= \frac{L}{kA} = \frac{0,013}{0,026 \times 1,2} = 0,416 \\
 R_{\text{wall } 3} &= \frac{L}{kA} = 0,0064 \\
 R_{\text{conv } 2} &= \frac{1}{hA} = \frac{1}{40(1,2)} = 0,0208 \text{ } ^\circ\text{C}/\text{W}
 \end{aligned}
 \left. \begin{array}{l} \\ \\ \\ \end{array} \right\} \begin{array}{l} \\ 0,532 \text{ } ^\circ\text{C}/\text{W} \\ = R_{\text{Total}} \\ \end{array}$$

$$Q = \frac{(T_{\infty 1} - T_{\infty 2})}{R_{\text{Total}}} = \frac{30}{0,532} = 56,39$$

$$Q = \frac{(T_{\infty} - T_1)}{R_{\text{conv } 1}} = \frac{20 - 0}{0,083} = 56,39 \Rightarrow 20 - 0 = 4,68$$

$$\Rightarrow T_1 = 15,3^\circ$$

Since conduction is better for transferring heat, the more conduction we have, the more heat would transfer by increasing the thickness of air, the way of transferring would be conduction otherwise it is convection that's why we have an optional range of thickness.

