TES_week1

martedì 8 ottobre 2019 18:08

/Summary:

CONDUCTION

How to calculate the heat that passes through a solid wall…

$$\dot{Q}_{in} - \dot{Q}_{out} = \frac{dE_{wall}}{dt}$$

dE_{wall} / dt = rate of change of the energy in the wall over time

FOURIER'S LAW OF HEAT CONDUCTION:

$$\dot{Q}_{cond,\ wall} = -kA\frac{dT}{dx} \qquad \text{(W)}$$

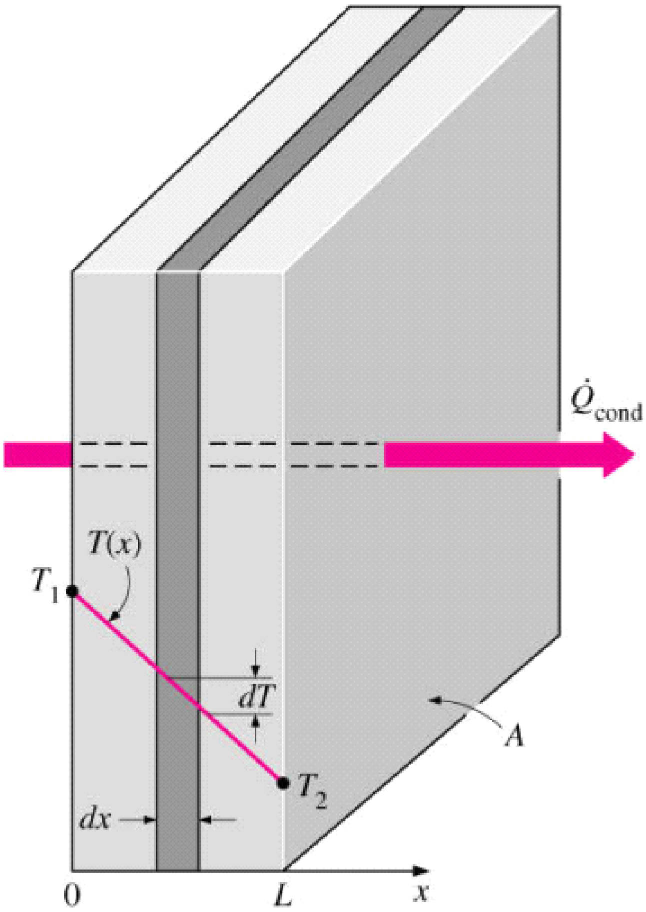
<u>where:</u>

k is the **conductivity** of a material = its willingness to transfer heat
A is the **area** of the wall

dT/dx can be considered as constant (in steady operation)

Which means that Fourier's Law can be written like this:

$$\dot{Q}_{cond,\ wall} = kA\frac{T_1 - T_2}{L} \qquad \text{(W)}$$



<u>where:</u>
$T_1 - T_2$ is the **difference of temperatures** between outside and inside
L is the thickness of the wall

This formula means that heat transfer through a wall is *proportional*:

- to its area
- to the difference of temperature
- to the conductivity

and *inversely proportional* to its thickness.

If we consider a new quantity, the *THERMAL RESISTANCE CONSTANT* (R)

$R_{wall} = L / kA$ (thinking at R like it is an electric resistance)

$$R_{\text{wall}} = \frac{L}{kA} \qquad (°\text{C/W})$$

This is how the Fourier's Law can be written:

$$\dot{Q}_{\text{cond, wall}} = \frac{T_1 - T_2}{R_{\text{wall}}} \qquad (\text{W})$$

The thicker the wall is, the higher its thermal resistance will be.
The lower the conductivity / the Area is, the higher its thermal resistance will be.

/Exercise:

Find the rate of heat trasfer through a wall if:
L= 0.4 m, A= 20 m2, DeltaT= 25, and k=0.78 W/m K

Use both **simple** method and **resistance** concept.

$$\dot{Q} = kA\frac{\Delta T}{L} = 0.78 \, * 20 * \frac{25}{0.4} = 975 \, W$$

Using R:

$$R_{\,wall} = \frac{L}{kA} = \frac{0.4}{0.78 * 20} = 0.0256 \, °C/W$$

$$\dot{Q} = \frac{\Delta T}{R_{\,wall}} = \frac{25}{0.0256} = 976.5625 \, W \; (slightly \; different \; because \; of \; rounding)$$