weekly_submission_01

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A short summary about the conductive heat transfer and solving the same exercise with $L = 0,4\ m$, $A = 20\ m^2$, $\Delta T = 25$ and $k = 0,78\ \frac{W}{m\,K}$ using both simple mathod and using resistance concept.

Conduction is the transfer of energy from the more energetic particles of a substance to the adjacent less energetic ones as result of interactions between the particles. In this case, conductivity is the willigness of a material to transfer heat. The unit of conductivity is $W/m\ K$.

Consider steady conduction through a large plane wall of thickness $\Delta x = L$ and surface area A. The temperature difference across the wall is $\Delta T = T_2 - T_1$.

Note that heat transfer is the only energy interaction; the energy balance for the wall can be expressed:

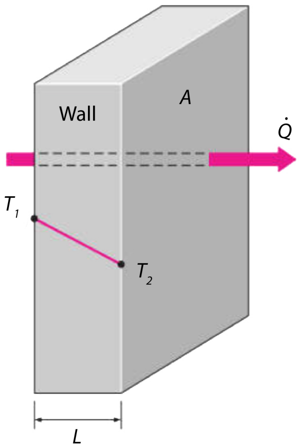
$$\dot{Q}_{in} = \dot{Q}_{out} = \frac{dE_{wall}}{dT}$$

$$\dot{Q} = \frac{dQ}{dt}$$

It has been *experimentally* observed that the rate of heat conduction through a layer is proportional to the temperature difference across the layer and the heat transfer area, but it is inversely proportional to the thickness of the layer.

$$rate\ of\ heat\ transfer \propto \frac{(surface\ area)(temperature\ difference)}{thickness}$$

$$\dot{Q}_{cond} = kA\frac{\Delta T}{L} \qquad (W)$$



The constant proportionality *k* is the *thermal conductivity* of the material. In the limiting case where $\Delta x \to 0$, the equation above reduces to the differential form:

$$\dot{Q}_{cond} = -kA\frac{\Delta T}{\Delta x} \qquad (W)$$

which is called Fourier's law of heat conduction.

Thermal conductivity $k\ [W/mK]$ is a measure of a material's ability to conduct heat. The thermal conductivity is defined as the rate of heat transfer through a unit thickness of material per unit area per unit temperature difference.

The Thermal Resistance Concept

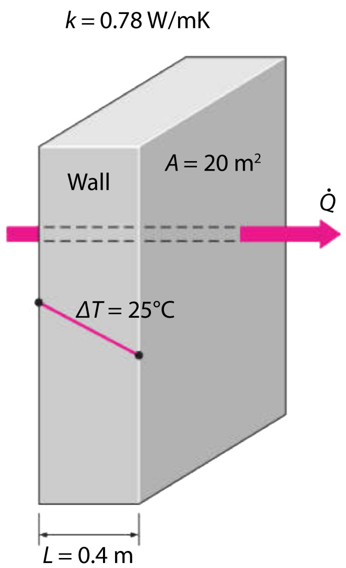
The Fourier equation, for steady conduction through a constant area plane wall, can be written:

$$\dot{Q}_{cond} = -kA\frac{\Delta T}{\Delta x} = kA\frac{T_1 - T_2}{L}$$

This can be re-arranged as:

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

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



EXERCISE

SIMPLE METHOD

$$\dot{Q} = kA\frac{\Delta T}{L} = 0{,}78 * 20 * \frac{25}{0{,}4} = 975\ W$$

RESISTANCE CONCEPT

$$R_{wall} = \frac{L}{kA} = \frac{0{,}4}{0{,}78 * 20} = 0{,}02564\ \frac{K}{W}$$

$$\dot{Q} = \frac{\Delta T}{R_{wall}} = \frac{25}{0{,}02564} = 975{,}03\ W$$