Week 1 _ mmartinolii

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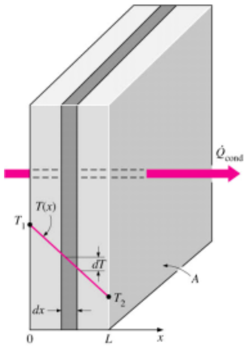
Heat conduction in plane wall

Heat transfer through the wall of a house can be modeled as steady and one-dimensional, the temperature of the wall in this case depends on one direction only (say the x-direction) and can be expressed as T(x).
In steady operation, the rate of heat transfer through the wall is constant and can be found with Fourier's law

$\dot{Q}$ cond. wall = $-\,kA\frac{dT}{dx}$

$\dot{Q}$ cond. wall = $kA\frac{T1-T2}{L}$

$\dot{Q}$ = $kA\frac{\Delta T}{L}$



T1 = temperature inside *
T2 = temperature outside *
L = wall thickness
A = wall area

* ΔT (T1 - T2) doesn't depend on the unit of measurement (°C or K = °C + 273,15)
for example:
T1 - T2 = 20 °C - 2 °C = 18 °C
T1 - T2 = 293,15 K - 275,15 K = 18 K
ΔT = 18 (in both cases)

For steady operation, when the temperature inside and outside is the same, the temperature distribution in a plane wall is a straight line dT/dx = const.

Week 1 exercise:

using simple method and resistance concept find the rate of heat loss through the wall.

L = 0.4 m
A = 20 m^2
ΔT = 25
k = 0.78 W/mK

- ***simple method***

  $\dot{Q}$ = kA x ΔT/L = 0.78 x 20 x 25/0.4 = 975 W

The rate of heat conduction through a plane wall is proportional to the average thermal conductivity, the wall area, and the temperature difference; but is inversely proportional to the wall thickness.

- ***"resistance concept" method***

  R = L/kA = 0.4/(0.78 x 20) = 0.0256 °C/W

  $\dot{Q}$ = ΔT/R = 25/0.0256 = 976.6 W

Conduction resistance of the wall is the thermal resistance of the wall against heat conduction, thermal resistance of a medium depends on its geometry and its thermal properties.